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THE EAST AFRICAN AGRICULTURAL JOURNAL

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Twenty-five separates of original articles will be sent free to authors if application is made at the time the manuscript is submitted.

Readers are reminded that all agricultural inquiries, whether they relate to articles in the Journal or not, should be addressed to the local Director of Agriculture, and not to Amani.

A CONFERENCE BETWEEN AN ANGLER, A FARMER AND AN EDITOR

(With acknowledgments to Izaak Walton)

PISCATOR: Sirs, I have here a little discourse on Trout Fishing, which I venture to think may be of interest to readers of your esteemed Journal.

AGRICOLA: I am a farmer, and see but little connexion between farming and fishing. Does not the poet Homer himself call the sea *atrugetoios*, that is, unharvestable?

EDITOR: Marry, Sir, you may remember your classics, but you forget that in England the interests of farming and angling are combined in one Ministry, that of Agriculture and Fisheries. If a great Ministry thinks the two not incongruous, surely my humble Journal may do likewise?

AGRICOLA: Yet for my part I consider angling a dull and contemptible recreation. Do we not talk of "angling for favours" and "fishing for compliments," and apply the epithet "fishy" to stories of doubtful veracity? And do you not recall Mr. Punch's picture of the lunatick looking over the wall of his asylum, and asking an angler how many fish he had caught? On hearing that the angler had caught none the whole day long, the lunatick invited him to come inside. And especially do I think that such a puerile pursuit is unsuitable in this grave time of war.

PISCATOR: Gentlemen, it is an easy thing to scoff at any art or recreation; a little wit mixed with ill-nature will do it. As for angling being unsuitable in war-time, I suggest that recreation of mind and body is even more necessary now than formerly, if we would keep our minds sane and our bodies ready for any emergency. I also can quote from a poet, even if he be not Homer.

As inward love breeds outward talk,
The hounds some praise, and some the hawk;
Some, better pleased with private sport,
Use tennis; some a mistress court:
But these delights I neither wish
Nor envy, while I freely fish.

Of recreation there is none
So free as fishing is alone;
All other pastimes do no less
Than mind and body both possess;
My hand alone my work can do,
So I can fish and study too.

I care not, I, to fish in seas—
Fresh rivers best my mind do please,
Whose sweet calm course I contemplate,
And seek in life to imitate:
In civil bounds I fain would keep,
And for my past offences weep.

I do not presume to scoff at hunting, or falconry, or tennis, and most certainly not at that other noble sport that my poet mentions; yet surely fishing is pre-eminently the recreation for war-time. For (should we be more skilful than your lunatick's acquaintance) we may thereby augment our food supply, and thus aid in frustrating the evil machinations of the unconscionable Adolf.

EDITOR: On whom be ten thousand malisons.

AGRICOLA: Sir, I am converted. I call to mind a Spanish proverb, that runs, if my memory is not at fault, as follows: "Rivers and the inhabitants of the watery element were made for wise men to contemplate, and fools to pass by without consideration." And the world would doubtless be to-day a happier place if Adolf had been an angler instead of a paperhanger. Perchance when I have read your lines I may even myself take to the rod and line.

EDITOR: Sir, that was wittily and gracefully spoken. So, my friend Piscator, I gratefully accept your article, which will doubtless be of much value to those many farmers who are already of your fraternity, and may be the means of converting others, such as our worthy Agricola. Therefore I will invoke the good offices of our friend the Government Printer, that he may insert your discourse on Trouts into our current number. (*See* "Trout in Kenya, Part I.")

T.W.K.

ERRATUM

"Some Further Observations on Coffee Thrips," Vol. V, No. 4.—On page 267, column 1, line 20, "Fig. 3" should read "Fig. 2."

A SOUND INVESTMENT POLICY

He who digs a well, constructs a stone fountain, plants a grove of trees by the roadside, plants an orchard, builds a durable house, reclaims a swamp, or so much as puts a stone seat by the wayside, makes the land so far lovely and desirable, makes a fortune which he cannot carry away with him, but which is useful to his country long afterwards.

—Ralph Waldo Emerson.

MENTAL EROSION

"Worry is a stream of thought trickling through the mind.

"If encouraged, it will cut a deep channel into which all other thoughts are drained."

—Wall text in a regional office of the U.S. Soil Conservation Service, Santa Paula, California.

THE ROOTING OF SOFTWOOD CUTTINGS OF COFFEA ARABICA

By L. M. Fernie, Agricultural Assistant, Coffee Research and Experiment Station, Lyamungu, Moshi, Tanganyika Territory

Introduction

At this station the rooting of softwood cuttings has proved to be the most successful method of vegetative propagation of *Coffea arabica*. Under favourable conditions over 75 per cent of those originally set in the propagating frames have rooted by the end of six months. Thus it is considered that the time has arrived to set out in full detail the technique employed, although, no doubt, there will be minor modifications as further experience is gained. The technique here described is that worked out to suit the conditions at the Coffee Research Station, Lyamungu, which is situated on the southern slopes of Kilimanjaro (latitude 3° S.) at an altitude of about 4,400 ft. The yearly rainfall shows great variation, the wettest months usually being April and May, when most of the year's rainfall occurs. There in a cool season after the long rains up till August, after which month the temperature can be expected to rise, reaching its peak in the hot dry months from January to March, when the aridity is great. The short rains are due about November, but are unreliable. It should be emphasized that the technique set out below will not necessarily apply to all coffee districts, with their varying climatic conditions.

Obtaining Material

Owing to the dorso-ventral habit of growth of the lateral branches of coffee, only material of vertical growth arising from the main stems is suitable for insertion as cuttings. Lateral wood merely produces low-growing bushes.

Mother-trees in the Field

The material available from mature trees in the field is not usually the most suitable, being in the form of "tops", or suckers growing on the main stem. These suckers are usually rather weak with elongated internodes, owing to the heavy shade under which they have developed. Nevertheless, it will usually be desired to propagate some particular tree owing to its marked superiority as regards bean yield, liquor, disease resistance, etc.; if mutilation of this tree is to be avoided, it is necessary to use whatever material is present. In this case, the suckers should be taken when very young, if possible three to five inches long, with only two or three nodes; the shorter the internodes the better chance there is of success in rooting.

Mother-trees in the Nursery

Having rooted one or more cuttings of the selected tree or trees, they should be planted out in a special clonal nursery for further intensive propagation. Obviously, where a large number of any one clone is required, as many rooted cuttings of it as possible should be planted out in the clonal nursery. As a guide for general purposes, it is suggested that twenty rooted cuttings of a single clone will provide a wealth of material. These should be planted out in nursery rows, four to five feet apart, and allowed to grow up on multiple stem. When sufficient growth has been made (after eighteen months to two years), the remaining primary branches are all removed, and each stem pegged down in a horizontal position. Suckers will then grow up vertically from the dormant "eyes" at each node, and provide a quality of suitable material to be taken as cuttings. (See Fig. 1). Each year it is advisable to leave a minimum of three new suckers, preferably arising at or near the base, to be pegged down in

their turn. The top of each stem is retained to draw the sap the full length of the plant, and this can be pegged down repeatedly when sufficient new growth has been made.

Artificial shade must be provided when establishing these young cuttings, but later all shade is best removed if local climatic conditions permit it. Otherwise, artificial shade should be provided during hot sunny weather; alternatively, shade-trees affording a light shade might be planted; *Sesbania aegyptica* can be recommended for this purpose.

Type of Material

In practice, when taking cuttings, it will be found impossible to select the ideal ones, and it will be necessary to take all the material available, provided that sufficient growth has been made. This can be done every four to six weeks during the growing periods. Nevertheless, the characters that constitute an "ideal" cutting may be summarized here:—

Normal sturdy growth, with healthy leaves.
Short internodes.
Rounded, not flattened, stems.
Length from 4 to 9 inches.

Propagating Frames

Frames with glass lids, wherein a high humidity can be maintained, are essential for the successful rooting of softwood cuttings of coffee. The dimensions of a type and size of frame found useful and efficient at Lyamungu are given below:—

Length	3 ft. 4 in.
Breadth	2 ft. 8 in.
Height of back wall ..	3 ft. 0 in.
Height of front wall ..	2 ft. 10 in.
Thickness of walls ..	4½ in.

For convenience, these frames are built in blocks of six, arranged back to back in two rows of three. Thus, overall dimensions for a single block of frames would be:—

Length	11 ft. 6 in.
Breadth	6 ft. 5½ in.
Height of centre wall ..	3 ft. 0 in.
Height of front walls ..	2 ft. 10 in.
Thickness of walls ..	4½ in.

Walls are built of cast concrete, but concrete blocks can be used. Three-quarter inch half-round grooves are made along the centre of all side walls, and one along each side of a central strip two inches wide on the centre wall. A length of hard timber 2″ × 2″ is bolted to this strip, and hinged glass lids are affixed to this.

Drainage

This is provided by means of stones at the bottom of the frames to a depth of from one and a half to two feet. The largest stones should be at the bottom, and they should gradually diminish in size until finally there is merely a layer of pebbles on top. This then provides a good base on which to place the rooting medium.

Rooting Media

To date, two trials have been carried out in an endeavour to ascertain the most efficient rooting materials for coffee cuttings. The media tried were:—

Leaf mould + fine white sand at 2:1 by volume.
Leaf mould + coarse river sand at 2:1 by volume.
Coco-nut fibre + fine white sand at 2:1 by volume.
Coco-nut fibre + coarse river sand at 2:1 by volume.
Coco-nut fibre + coarse river sand at 1:1 by volume.
Peat moss + fine white sand at 2:1 by volume.
Peat moss + coarse river sand at 2:1 by volume.
Peat moss + coarse river sand at 1:1 by volume.

Results of these trials were published in the Quarterly Notes of this Station Nos. 9 and 11 for March and September, 1939, respectively, but they may be summarized below.

In the first preliminary trial no attempt was made at any repetition of the treatments, and so any statistical analysis of the results was impossible. The conclusions drawn were as follows:—

Peat moss was the most efficient organic material used. It is also the most expensive.

Coco-nut fibre has possibilities as a substitute for peat moss, but cuttings in this take longer to root.

Leaf mould is cheap to make, and can be used, but is only recommended when the other materials are unobtainable.

Generally speaking, a coarse sand is preferable to a fine one.

In the second trial, leaf mould was excluded, as was the use of fine sand. Peat moss and coco-nut fibre were both used mixed with coarse sand at 2 : 1 and 1 : 1 by volume. Each treatment was duplicated, and the plots were randomized in two blocks. Unfortunately the performance of all treatments in one block fell far short of those in the other, and the treatment differences were not statistically significant. Nevertheless, as regards time to root, the following significant results were obtained:—

Peat moss + sand (2:1) significantly better than coco-nut fibre + sand (2:1).

Peat moss + sand (1:1) significantly better than coco-nut fibre + sand (2:1).

Coco-nut fibre + sand (1:1) significantly better than coco-nut fibre + sand (2:1).

In block 2 and combined blocks only: peat moss + sand (2:1) significantly better than coco-nut fibre + sand (1:1).

In block 2 only: peat moss + sand (1:1) significantly better than coco-nut fibre + sand (1:1).

From this we can conclude that, in regard to time required to root:—

Peat moss is a more suitable organic material than coco-nut fibre.

If coco-nut fibre is used, it should be mixed with coarse sand in equal proportions by volume rather than 2 : 1.

Sterilization of Medium

Sterilization by steaming or baking the rooting materials has not so far been found necessary. At present, when any fresh rooting materials are inserted in the frames, they are always well watered-in with a solution of Cheshunt Compound. The walls of the frames are washed with this solution at the same time. This is the only routine form of sterilization applied. Formalin has been used with advantage for cleansing the frames, but it is a stronger disinfectant than Cheshunt Compound, and not suitable for use on living plant material. If formalin is used, the medium so treated should be left for a fortnight before cuttings are set in it.

Taking and Setting of Cuttings

Cuttings are best taken when the relative humidity is comparatively high; in practice the early morning is probably the best time. It is immaterial whether a knife or secateurs are used for severing from the mother tree, as each cutting should always be re-cut at the base, immediately prior to setting in the rooting medium.

The basal cut is made with a sharp knife just below or through a node; oblique or practically horizontal cuts appear to be equally effective provided that the cut surface is clean. The lower leaves should be removed entirely, also any small primary branches that may be present. The remaining leaves are trimmed to prevent straggling and to save space in the propagating frame. It is important to retain as much leafage as possible, and therefore not more than one-third of the small leaves and one half of the mature leaves (if any) should be removed. Cuttings with only a small leaf area, even if they do root, have small chance of survival afterwards. The cuttings are inserted into the medium to a depth of from $1\frac{1}{2}$ to 2 inches. The medium should be kept as porous as possible and no attempt made to consolidate it round the stems of the cuttings. From 250 to 300 cuttings can be accommodated in a frame of the dimensions given above. An experiment is projected

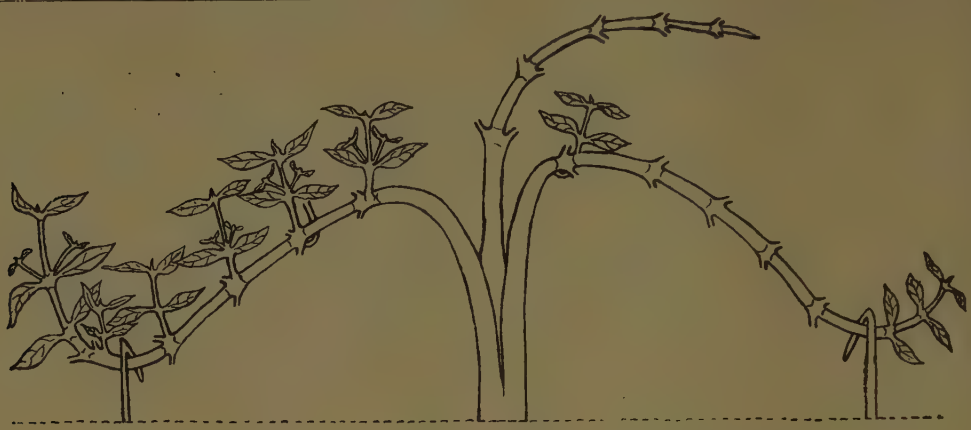


FIG. 1
Showing how suckers arise from the "eyes" at each node, when the main stems are pegged down horizontally.

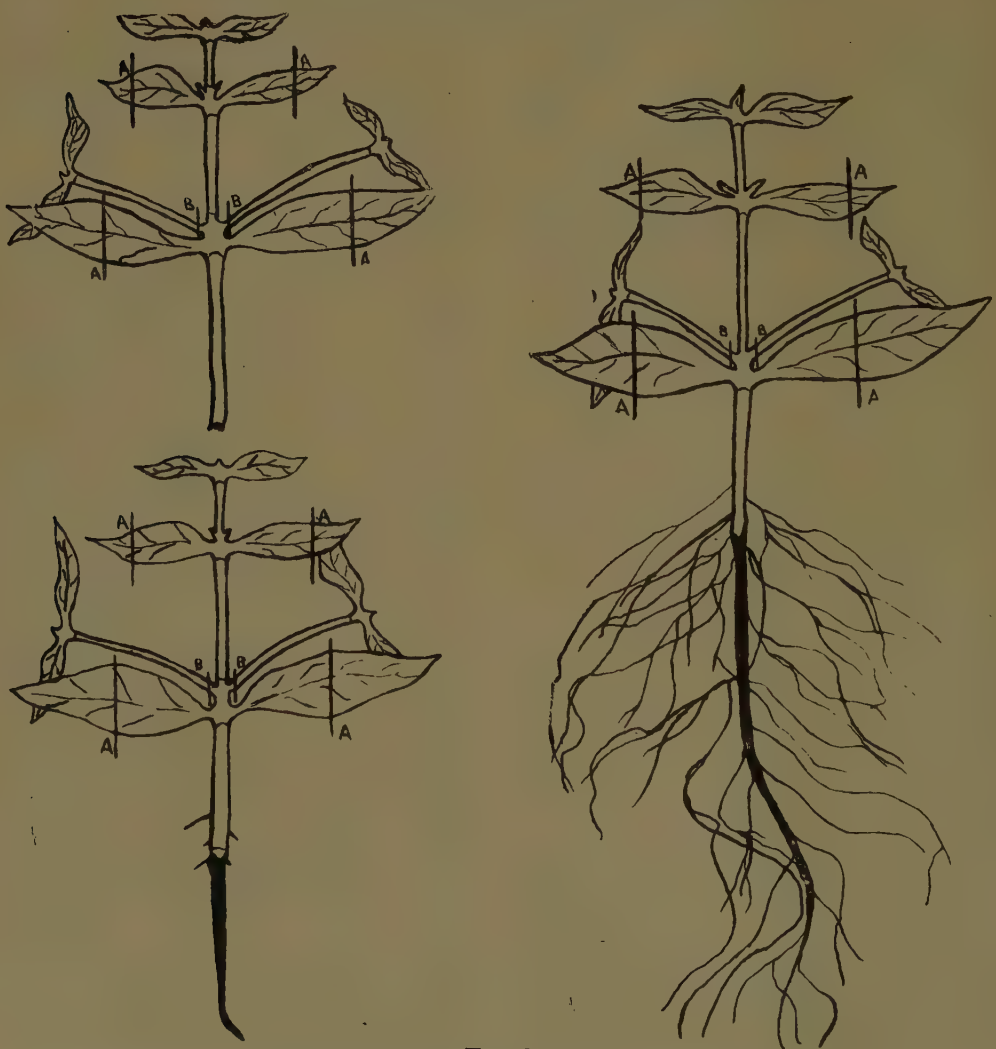


FIG. 2
The stages of root development of cuttings of *Coffea arabica*. Leaves and primaries are trimmed at the lines marked A and B respectively.

to ascertain whether a smaller number per frame would give better results, and generally be worth while.

Temperature and Humidity

Under the conditions prevailing at Lyamungu no bottom heat is required. During the hot dry weather it is necessary to concentrate every effort towards keeping the internal temperature of the frame down to between 20° C. and 23° C. This is done by means of frequent waterings with cold water on the outside of the glass lid.

A practically saturated atmosphere is necessary in the frames. The relative humidity is kept up to about 90 per cent by means of a fine mist spray over the cuttings, once or twice a day according to the external climatic conditions. As a general rule this should also provide sufficient moisture for the rooting medium, after the initial watering it has received. Clean water only, from spring or tap, should be used.

Ventilation

Since, as is stated above, a practically saturated atmosphere in the frames is necessary, it is obvious that the amount of ventilation is greatly limited by the humidity requirements. The frames are normally opened for short periods each day for purposes of spraying and for routine examination of cuttings, etc. In addition, the three-quarter inch grooves made along the top of the concrete walls provide a small degree of ventilation. This should suffice. If, for any reason such as potting-up rooted cuttings, the frame is open for some considerable time, the high humidity must be restored by spraying the cuttings before closing the frame again.

Light

It is probable that leafy cuttings of all evergreens require light to enable them to strike root successfully, and coffee is no exception. At the same time, it is important that direct sunlight should not be allowed to fall upon the propagating frames. Not only would this scorch the tender young leaves, but it would also make it impossible to maintain the high humidity that is so essential. An overhead shade of a material such as hessian affords the maximum amount of light, but at the same time wards off direct sunlight. This is best supported on some permanent structure of wire, wire-netting, or expanded metal, some nine feet above the ground. Care should be taken to provide sufficient overlap, or side-screens, to ward off the oblique morning and evening sun.

Routine Treatment of Cuttings

Apart from the daily sprayings over the cuttings and watering on the outside of the glass lids of the frames when necessary, the cuttings should be examined frequently. Any diseased leaf or part of a leaf should be removed and burnt, and a sharp look-out be kept for insect pests. A certain amount of leaf-fall is inevitable, and all fallen leaves should be removed; dead and rotting cuttings should likewise be taken out and burnt at once. Those cuttings that die appear to do so during the period three to six weeks after being set in the frames.

Callus and Root Formation

Callus formation normally begins about three weeks after the cuttings have been set in the rooting medium, and a complete ring of callus can be expected five to six weeks after the date of setting. It is not until then that root initials are apparent, and the first cuttings to root out of a single batch usually do so about $2\frac{1}{2}$ to 3 months from the date of setting. Fig. 2 illustrates the stages of root development. Under favourable conditions about 75 per cent of those originally inserted can be expected to root during the six months following the date of setting. After that time, odd cuttings will

root intermittently up to a period of 1½ to 2 years, when possibly 85 per cent or more of the original batch may have rooted, but unless it is essential to obtain the extra 10 per cent, it is better to start afresh with new cuttings.

Roots are normally obtained from the callus only, but adventitious roots have been noticed arising from the stem, as much as 1½ inches from the base. It is thought that the tap-root or tap-roots (there may be more than one) always arise from the base, and in those cases where adventitious roots arise from the stem first, the tap-roots will be formed subsequently in the usual way.

After-treatment of Rooted Cuttings

When the cuttings have struck, that is when roots one to two inches long have been produced, they are potted-up into banana baskets, containing a rich compost to which a little fine white sand has been added. They are immediately returned to the frames for three or four weeks, or longer if the leaf area is small, to recover from the check of transplantation. Thence they are removed to a cool place outside under shade, where they harden off for a further two or three months. At the end of that period, the baskets should be full of roots, and the young clones are ready to plant out in the nursery, still under shade, to await transplantation to the field, or intensive propagation in the nursery.

Use of Growth-promoting Substances

There are an ever-increasing number of synthetic substances, of the nature of plant hormones, known to promote root-formation on cuttings of many plants. Softwood cuttings of coffee have been treated with some of these, so far with little success. In the original trials, it was hoped that the cheaper rooting materials, such as leaf mould, might be used with great success if the cuttings inserted therein were previously thus treated, but this hope has not been realized. Further work with these substances is necessary, for they obviously have great possibilities.

Leaf-bud Slips

It may be mentioned here that success on a very small scale has recently been obtained with leaf-bud slips of both *Coffea arabica* (see Fig. 3) and *robusta*. Strong sturdy roots were obtained two to three months after setting, but shoot formation was slow. This latter difficulty might be overcome if a more careful selection of buds was undertaken to exclude the very immature ones. It is considered that this method of softwood propagation merits further investigation.

Fig. 3

A rooted leaf-bud slip of *Coffea arabica* at six months after setting. All shoot-growth (except that of original leaf, which can be clearly seen) was made subsequent to rooting.

Pests and Diseases

Pests

Thrips, Green Scale, Leaf Miner and Aphis have all been found at times in the propagating frames, but can be controlled with care and attention.

Thrips (*Physothrips xanthoceros* Hood) is inclined to be very troublesome during

the hot weather. Control measures are aimed at keeping the frames as cool as possible. Infested cuttings are dipped in a solution of nicotine sulphate (at 1 : 500), and, as a precaution during this period, all freshly taken cuttings should be similarly treated before being set. The basal end of the cuttings should not come into contact with the solution.

Green Scale (*Lecanium viride* Green) is best controlled by hand-cleaning the infested cuttings with a solution of Orthol K (at 1 : 40).

Leaf Miner (*Leucoptera* sp.) is particularly serious on cuttings, for it necessitates the entire removal of all infested parts of leaves. When a large leaf area is removed the cutting has little prospect of survival.

Green-fly (*Aphis* sp.) is not a serious pest in the frames, but its presence has been observed. Control is effected by dipping cuttings in a solution of nicotine sulphate (at 1 : 500).

Diseases

Hemileia vastatrix.—All infected leaves should be cut off, removed, and burnt; or cuttings could safely be dipped in Bordeaux mixture.

"Damping off" (*Rhizoctonia* sp.).—This was a serious disease a few years ago, but the watering-in with Cheshunt Compound of all freshly inserted rooting materials, which is now a routine practice, appears to be a sufficient precaution. There seems to be no doubt that it is introduced by means of the organic rooting materials, so that, if the disease assumes alarming proportions, sterilization of the materials and a thorough cleansing of the frames with some stronger disinfectant such as formalin would be necessary.

Summary

Suckers from original mother-trees in the field should be rooted, and subsequently established in a special clonal nursery, where their main stems can be pegged down horizontal with the ground, and suckers allowed to arise vertically from the dormant "eyes."

Normal suckers, four to nine inches long, with healthy leaves, short internodes and unflattened stems provide the most suitable cuttings.

Frames with glass lids are essential, and a good drainage must be provided.

Peat moss + coarse sand in the proportion of 2 : 1 by volume is the best rooting medium so far tried. Coco-nut fibre is slower but is an efficient substitute for peat moss. It is best mixed with coarse sand in equal proportions by volume.

The leaves of all cuttings should be trimmed, but leafage must not be unduly reduced.

Temperature, humidity and light must all be regulated.

The majority of the cuttings will root during the period three to six months after setting.

Rooted cuttings are potted-up in a rich compost in banana baskets, returned to the frames, and then placed outside to harden-off before being planted out in the nursery.

Success has not yet been obtained in the treatment of softwood cuttings with growth-substances.

Pests and diseases are troublesome, but can be controlled with care and attention.

Acknowledgment

Acknowledgment is due to Mr. C. B. Gibbins, my predecessor in charge of the vegetative propagation of coffee at this station, who carried out the earlier work (up till the end of 1937) on which the present methods are partly based.

CALF REARING*

By R. S. Ball, M.A. (Cantab.), Dip. Agric. (Cantab.), A.I.C.T.A.,
Agricultural Officer, Kenya Colony

A considerable amount of information is available on the best methods of management of dairy herds in the various areas of the country, and the standard of husbandry has greatly improved during recent years. As a result of more intensive management there has been a tendency to rear more calves by hand than formerly. Results have, however, in some cases been disappointing, and it may be that under certain conditions in this country it is better to use natural methods.

This applies particularly in the large ranching areas where supervision at milking time may be difficult and where the calf when weaned has to fend largely for itself, frequently under somewhat adverse conditions. The very gradual weaning process which the calf undergoes on a cow which either is being milked and is gradually drying off or is adjusting its milk supply to the requirements of the calf, helps to maintain the calf in flesh while it is becoming accustomed to the conditions under which it must forage. Many mistakes have been made by attempting to hand-rear calves where it is not possible to supervise the feeding adequately, so that the milk is fed cold and causes digestive troubles and scour, or dirty utensils are used. Furthermore, milk to be fed to the hand-reared calves is liable to be stolen, so that they do not actually receive their allotted quantity. These factors are, however, no real drawback to the adoption of hand-rearing methods provided supervision is given and that young stock when weaned have not to withstand hard conditions under which they might go back in condition. Farmers who wish to hand-rear their calves should therefore be prepared to give adequate supervision to the work. Having decided which method to practise, it is necessary to follow some plan.

Natural Raising

Undoubtedly the best method is to allow the mother to suckle its calf completely, but this system has a drawback—the cow quickly adjusts its milk supply to the requirements of the calf, and the cash return from the cow in the form of one weaned calf at intervals of approximately fourteen months is too small, except where abundant cheap land is available and there is a ready market for slaughter stock. In the large ranching areas this method may be justified, particularly if female stock of low-yielding capacity and bulls of predominantly beef breeds are being used. Generally, however, in Kenya the value of the land and the outlet for beef do not justify the farmer devoting his cows to the rearing of calves only, and some form of ranch dairying is therefore practised. Several methods of calf feeding are adopted under this system, the commonest being that the calf is allowed to run with its mother to suck during the day and is removed at night, the cows being milked in the morning only. Since they secrete most milk at night, if the cows are low yielding the calf will receive little food and may be stunted as a result. If, however, the female stock are capable of yielding sufficient milk to do the calves reasonably well, this system has no great disadvantages except the one inherent in all

* Revised from Kenya Agricultural Bulletin No. 18 of 1931, which was written by W. D. D. Jardine, B.Sc., N.D.A., N.D.D., then Live Stock Officer, Kenya.

natural raising methods, i.e. that it is impossible to assess how much milk the calf does actually receive.

If the cows are milked twice daily, it is a common practice to milk all four teats partially and allow the calf to have the remaining milk, which is of course the richest in butterfat. Alternatively, two quarters may be left for the calf and the other two milked out completely, but this method may be unsatisfactory unless the teats are alternated, since it may lead to uneven udder development.

There is a considerable diversity of opinion as to which of these methods is the most satisfactory, but probably the ultimate decision depends largely on whether skim milk is available for feeding the calves in addition. If it is, then twice-a-day milking without stripping is preferable, the calf having access to all four teats. The fact that the calf obtains in this manner milk excessively rich in butterfat may be off-set by the feeding of skim milk, with possibly a butterfat substitute in the middle of the day. If, however, skim milk is required for other purposes, such as pig feeding, or the milk is sold, then it is probably preferable to allow the calf to suck two out of the four quarters twice daily, alternating these and adjusting the number actually allowed to the yield of the cow.

It is, however, also possible to foster a certain number of calves on cows which may not be worth milking on account of low milk yield, or which may be very difficult milkers or may have lost one or two quarters. Two bull calves may be suckled on a poor milker, while the more important heifer calves are suckled by better milking cows suffering from some defect, such as a lost quarter, that renders them useless in the herd. A good milker can often rear four or five calves during a lactation, and a cow that is once accustomed as a foster mother will give little trouble. At first, however, it is often necessary to tie the cow up and perhaps to tie her legs, taking care that she lets down her milk when the calf commences to feed. A cow that has lost her calf can have another one introduced to her by putting the skin of the dead calf over the new one.

A large number of farmers are, however, hand-rearing their calves, and this method is undoubtedly most satisfactory for the dairy farmer, since it enables the exact necessary quantity of milk to be fed, and the amount to be varied if conditions make it necessary. Strict supervision is, however, essential if calves are to be hand-reared successfully. Before, however, considering in detail the food requirements of the calf and methods of feeding, some general observations on husbandry are necessary.

Housing

Adequate housing is a factor of great importance for hand-reared calves, the most essential feature being isolation of each individual calf so as to prevent them from sucking each other and to afford them the necessary protection. In the past there has been a tendency to erect expensive calf houses with a view to ease of disinfection and disease control, but nowadays farmers are devoting more attention to movable pens or rough stick-and-grass pens which can be destroyed and rebuilt at very low cost. In either of these ways it is possible to move away from disease rather than to attempt to control it by elaborate disinfection of permanent buildings. The individual movable pens are generally about 4 ft. 6 in. by 4 ft. in size and are made cheaply of wattle or other timber completely enclosed with roofs of corrugated iron, with a layer of grass wedged in underneath to prevent them from becoming too hot during the day. The pen is lifted down

over each calf, and a bail may be inserted in the front for feeding or the pen itself may simply be tilted up to insert the pail. The pens are moved frequently over grassland, and since they have no floor the calf is always standing on fresh grass. These pens are cheap to build, enable each calf to be isolated completely, and the calves are confined in them entirely for the first five to six weeks of their lives. Their only disadvantage lies in the fact that in a high-altitude area they may be rather cold and damp unless litter is provided in the form of straw or grass and protection is afforded by nailing sacks on the sides of the pen in the direction of the prevailing wind. Furthermore, they can be easily moved round in conjunction with a portable milking outfit, thus enabling pastures to be improved. This has the further advantage that they can always be kept close to the movable milking bails so that the hand-fed calves can receive their milk warm, no long transport being necessary.

Some farmers prefer to construct rough stick-and-grass pens which are left in one site for six months, and then destroyed and a fresh series built. These are probably superior for use in the high-altitude areas, since they can be made warmer and afford greater protection to the calves than the movable pens, the essence of the construction of which is lightness. If, however, permanent calf pens are built it is possible to put up cheap buildings with rammed earth floors, provided plenty of litter is used and is cleared out daily. Wheat straw is the most suitable for the purpose, since it harbours no ticks or lice and provides an excellent and comfortable bedding. The tendency previously referred to towards the construction of buildings for calves with stone or concrete floors, which were not kept adequately littered and were frequently washed down with cold water, combined to produce chills and scours, which would not be experienced if adequate bedding and litter were provided. The essence of permanent buildings should be individual pens, size 5 ft. by 4 ft., and a free circulation of air over the calves provided by a layer of wire netting under the eaves of the building.

A tendency in this country to overhouse calves should be avoided, and except where confined in the movable pens on grass as described above, it is desirable that after the age of four weeks they should run out daily on improved pasture. For this purpose, it is important to have a series of paddocks, since grass easily becomes stained with worms to which young calves are highly susceptible. Shade is desirable in these paddocks, and quick growing trees should be established if indigenous trees are not present. Paddocks of grasses such as Kikuyu grass or Star grasses (*Cynodon* sp.) are preferable, since these are not generally as fibrous as the veldt grasses. It is generally desirable to house calves during the heat of the day unless heavy shade is available in the paddocks.

It is not essential to house the calves individually after the age of three months; larger pens may be used. But where they are housed individually for a longer period they generally do better, and since this principle is applied where the individual movable pens are used it is a further recommendation for that practice. Considerations of space, however, may render it necessary to house the calves together after three months, and if this is so they should be tied up for a short time after feeding so as to reduce the tendency to suck each other.

Removal of Calf

There is a divergence of opinion as to the best time to remove the calf from its mother, but it is probable that the sooner

it is removed the better, i.e. as soon as dropped. In this manner the cow has no time to develop any maternal instinct, and will settle down quickly, whereas if the calf is left with her for twenty-four hours till thoroughly dry, or for three days in order to suck the colostrum direct (as is a common practice), she is liable to be a nuisance by hanging round the milking bails and calf pens and knocking these about if they are accessible. Furthermore, she will not settle down to graze or feed properly, which may have an adverse effect on both her condition and her milk supply. When the calf is removed immediately at birth it should be thoroughly dried and the navel tied with string dipped in a weak disinfectant solution, so as to prevent the entry of disease germs. The colostrum or first milk should then be removed from the cow and fed to the calf three times daily for three days. Some farmers prefer not to feed the calf for the first day, for it will then take to pail feeding much more readily since it will be really hungry. At this stage the greatest stress must be again laid on the absolute necessity for feeding the milk warm in properly cleaned vessels, since if a young calf receives it in a cool or cold condition serious digestive disorders are likely to occur and may result in death.

To estimate the amount of milk required by a young calf, allow a quantity equal to 10 per cent of the live weight of the animal daily. Thus a calf which weighs 75 lb. at birth would require approximately 7.5 lb. or three-quarters of a gallon of milk daily. This method of calculation may be used up to an age of three weeks, when skim-milk feeding will probably commence. It is of course difficult to lay down feeding standards owing to the widely different types of animals that are bred in the country, but a ration which has proved very satisfactory under a wide range of conditions is as follows:

FEEDING OF HEIFER CALVES

AMOUNTS PER HEAD PER DAY

GALLONS

Week	Whole Milk	Skim Milk	Concentrates	Roughages
	Gal.	*Gal.*		
1st ..	¾	—	—	—
2nd ..	1	—	—	—
3rd ..	1	—	—	—
4th ..	1	½	Up to ¼ lb.	Commence roughages and/or grazing.
5th ..	¾	½	¼ lb.	
6th ..	½	½	½ „	Silage and Lucerne Hay
7th ..	½	¾	1 „	— 1 lb.
8th ..	½	1	1½ „	— 1 „
9th ..	¼	1	1¼ „	2 lb. 1½ „
10th ..	¼	1	1½ „	2 „ 1½ „
11th ..	—	1¼	1½ „	3 „ 2 „
12th ..	—	1¼	1½ „	3 „ 2 „
13th ..	—	1	1½ „	4 „ 2½ „
14th ..	—	1	1½ „	4 „ 2½ „
8 months	—	1 to nil at end of 8 months	2 „	5-8 „ 3½ „

A daily live weight gain of 1 lb. should be obtained with these rations.

If no skim milk is available, then continue whole milk, one gallon daily, till the end of the fifth week; then reduce and increase concentrates and fodder. It should be noted that the system described above is designed to rear good high-grade heifer calves, but is naturally somewhat expensive since it will require about 48 gallons of whole milk and approximately 150 gallons of skim, the combined value of which (whole milk 35 cents and skim milk 7 cents per gallon) totals approximately Sh. 27/30.

The above table is designed only to give an idea how calves should be fed and the quantities of milk necessary at the various ages. The appetities of different animals vary greatly and each has to be fed according to its requirements and condition. For pure-bred stock it will be necessary to increase the amounts in proportion to the higher average weight of the calves. A pure-bred calf of one of the larger dairy breeds will probably weigh 80 to 100 lb. at birth, thus necessitating one gallon of whole milk during the first week, later increasing to one and a half

or even two gallons daily where rapid growth and bloom is an important factor, as in herds where bull-breeding is the chief aim. Skim milk should not be fed in such cases till the fifth or sixth week, and the feeding of whole milk should be continued until the sixteenth week; for pure-bred bull calves, till the twenty-fourth week.

Rearing of Steer Calves

At the other end of the scale is the farm where the steer calves are to be reared as cheaply as possible, since their value is low, and whether destined to be sold as stores or fat stock are not likely to yield a high cash return. Such steers will often be raised on farms where ranch dairying is practised, so that the problems connected with hand feeding do not arise, but where sufficient land of ranching type unsuitable for intensive dairying is available for grazing it may be profitable also to rear steers on farms on which hand-feeding is practised. It is doubtful whether a yearling steer can be produced at a cost of under Sh. 25 (whole milk and skim milk or substitutes Sh. 9/45, feeds Sh. 6, herding, labour, etc., Sh. 10). Under most conditions, allowing for the necessary whole milk, skim milk and milk substitues, the rearing of this class of stock may only be justified on dairy farms where skim milk is not required for other purposes, such as pig feeding, and where adequate cheap land is available for the subsequent grazing of the stock.

In view of the relatively low and slow return which is returned by store and fat steers, farmers are inclined to do them poorly as calves, and it is not uncommon to see the steers in an unthrifty pot-bellied condition with harsh coats, due to the fact that inadequate whole milk has been fed to them in the early stages of their growth. At the same time, however, it is probable that considerably reduced amounts of whole milk can be fed as compared with the heifer calves, and although this is not conducive to the most rapid growth yet it does give reasonably satisfactory results. A suggested table for the cheap rearing of steer calves is added:—

GRADE STEER CALVES

Week	Whole Milk	Skim Milk	Concentrates	Roughages
	Gal.	*Gal.*		
1st ..	½	—	—	—
2nd ..	½	¼	—	—
3rd ..	¼	½	—	—
4th ..	¼	¾	—	—
5th ..	—	1¼	—	—
				Silage Hay
6th ..	—	1¼	½ lb.	— ½ lb.
7th ..	—	1	½ „	— ¾ „
8th ..	—	¾	½ „	2 lb. 1 „
9th–12th..	—	½	1 „	4 „ 2 „
13th ..	—	Nil	1½ „	6 „ 3 „

Cases are known where smaller quantities of whole milk even than those described above are used and fat substitutes added to the skim milk. It is probable that on the dairy farm, where milk is sold in the form of butterfat to a creamery the feeding in the table described above will prove to be economic, and greater substitutions for whole milk would only be justified where higher prices were realized for liquid milk. In such a case it is doubtful whether the rearing of steers would be a profitable proposition.

The markets available for beef in Kenya at the present time frequently justify the farmer rearing dairy-bred stock destined for slaughter. If, however, an improvement in quality is ultimately to be achieved it will be necessary to rear only calves bred for beef, or at least of dual purpose type. The use of beef bulls on the lower producing dairy animals will be justified when the farms are stocked up with female dairy stock, a position which is rapidly being achieved in certain areas.

Milk Substitutes

In some cases farmers are anxious to feed fat substitutes so as to make greater use of skim milk available and to reduce the amount of whole milk required to all

classes of calves. While it is doubtful whether any of these substitutes are as effective as feeding the correct proportions of whole milk, yet they undoubtedly enable certain economies in feeding to be made. Probably the one most widely used is cod liver oil, or preferably halibut liver oil, if it is available at a reasonable price. These are added in small quantities, generally at the rate of one tablespoonful per gallon, to the skim milk in order to replace the fat that has been removed, and since they contain the necessary vitamins probably constitute the best form of fat supplement.

Failing these, certain others are commonly available, such as linseed oil and other vegetable oils. These have the disadvantage that, although considerably cheaper, they are not so digestible. Linseed can be produced cheaply on a large number of farms and it has a widespread use as a fat substitute. The easiest way to prepare it for use is to pour boiling water over the seed, sufficient to cover it thoroughly, and then continue to boil for a few minutes. It is desirable to pour boiling water over rather than to heat slowly, since this bursts the skins of the seeds more effectively. It is necessary to continue to boil thoroughly so as to avoid all danger of possible poisoning by cyanogenetic glucosides. The liquid which results from this process is in a semi-jellified form, and one cigarette tin (50 size) of this should be added to each half-gallon of skim milk when feeding, and thoroughly stirred in.

The fat may also be added in the form of a vegetable oil, such as linseed or other variety, direct to the skim milk, in which case one tablespoonful is required added to each quart. Feeding of these substitutes is generally recommended only for steer calves, and it is always desirable to continue the heifers on the whole milk diet where possible.

Farmers close to a creamery may be able to obtain buttermilk or whey. Buttermilk, provided it is not greatly diluted with churn washings, may be substituted equally for skim milk in the rations, since its composition is very similar except for a slightly lower protein content. This can be remedied by the inclusion of slightly more protein in the dry concentrates fed to the calves. Buttermilk should be obtained fresh and kept in clean vessels, as if allowed to sour it can cause scouring and digestive troubles. A limited amount of whey may be available. This product is more deficient in protein than skim milk or buttermilk, and requires a further increase in the concentrates fed in the meal rations of the calves. This is usually effected by feeding a higher percentage of linseed. Whey also should be stored in absolutely clean vessels, otherwise it is liable to be dangerous in feeding.

Other Feeds

It is important to commence feeding concentrates and roughages as soon as calves are able to pick at them, since in this manner the rumen will develop adequately at an early age. Prolonged feeding of excessive quantities of skim milk or milk products is likely to hinder the animal's ability to digest other feeds properly and generally the feeding of concentrates and roughages of high quality is likely to produce better results than if attempts are made to avoid the feeding of these by using large quantities of skim milk at ages over those described in the tables. Calves will commence to pick at small quantities of concentrates and roughages shortly after an age of three weeks, and it is desirable that they should have access to these as soon as possible. The rations should be of good quality and easily digested, and should not be excessively rich in vegetable fats, which are difficult for young animals to digest.

Suitable concentrate mixtures which can be cheaply compounded largely of home-grown foods are appended:—

PARTS BY WEIGHT

½ part linseed 1 part pollards ¼ part bran	1 part linseed 1½ parts crushed oats ½ part bran
½ part linseed ½ part pea-meal 1 part oats ½ part bran	1 part linseed 1 part crushed oats ½ part maize meal ¼ part bran

½ part linseed
1 part rye or wheat meal
¼ part bran

Bulky and rather fibrous concentrates, such as cotton seed and corn-on-the-cob meal, should be avoided for young calves, and maize meal should only be fed in very small quantities. Cotton seed in particular is an undesirable food owing to the amount of indigestible lint attached to it, and also on account of its slightly poisonous character when fed to animals which are not grazing freely. Bran is an extremely useful food in such rations on account of its digestibility, but if other feeds of good quality are available on the farm it can be done without, since it is often difficult to obtain and is frequently expensive. Concentrates, during the first week or more when commencing to feed, should be placed before the animals the whole time, but afterwards should be fed once daily, at noon if the calves are fed milk twice daily, or in the morning if fed milk three times.

With regard to roughages it is desirable to commence feeding these also as soon as possible, unless good paddocks with high quality grazing are available; but grazing should in any case be supplemented by suitable roughages during the dry season. Lucerne hay fed in nets in the calf pens is a suitable feed, but on the majority of farms where this will not be available good quality silage (maize or oats) or oat hay can be used, and the calves will commence to eat these in very small quantities at an age of six weeks, until they consume about 3 lb. of silage daily at two and a half months.

In addition, a mineral lick should always be available for the calves, and such a lick may be made as follows:—

50 per cent salt.
30 per cent bone meal.
30 per cent lime.
2 oz. cobalt nitrate per 100 lb. of the mixture should be added in Nakuruitis areas.

The importance of accustoming young calves to feeding cannot be over-stressed, since only in this manner is it possible to prevent them from standing still when the milk ration is eliminated. It is very undesirable that young hand-reared calves should be weaned completely off milk and then left to range for themselves over a considerable acreage of possibly indifferent grazing without additional feeding. In the case of ranched dairying this problem should not arise, since the calf is weaned gradually and has been able slowly to accustom itself to the prevailing conditions. Further, the age at which it will be weaned will in all probability be greater than in the case of the hand-reared calf. Farmers sometimes complain that their hand-reared calves do not do as well when weaned as ranched calves, and this is probably true where it is not possible to give the necessary care and attention on weaning, as is often the case on the larger cattle farms.

When weaned, therefore, heifer calves should continue to receive a concentrate ration which should be fed in the middle of the day if possible, and in the evening during the dry season or periods of shortage of grazing they should continue to receive hay and silage. Examples of suitable rations and the quantities in which they should be fed are appended below:

Period	Concentrates	Hay or Silage	
		Silage	Hay
6 months to 1 year ..	2 parts	10 lb.	6 lb.
1 year to 2 years ..	1½ parts	15 „	8 „

RATIONS PARTS BY WEIGHT

SIX MONTHS TO ONE YEAR

1½ parts pea-meal	1½ parts linseed meal
1 part corn-on-the-cob meal	1 part crushed oats
½ part barley	½ part barley
	½ part maize meal

1½ parts linseed meal
1 part corn-on-the-cob meal
½ part barley

ONE YEAR TO TWO YEARS

1½ parts cotton seed	1 part pea meal
1 part corn-on-the-cob meal	1½ parts corn-on-the-cob meal

The cost of such rations is not great, and it is important to remember that as stock are being graded up rapidly in most areas and pure-bred bulls are being used, there is an increasing necessity for feeding the young stock adequately, so that the breeding policy may not outstrip the policy adopted in feeding. The returns obtained more than compensate for the additional cost of feeding the heifers from weaning onwards, since it is reflected in ability to bull at an earlier age and greater regularity in breeding. In addition, continued feeding makes the animals quiet and easy to handle, so that they will give little trouble and let down their milk easily when they themselves calve. There is a considerable diversity of opinion as to the age at which heifers should be bulled in Kenya, and of course this will depend on breed, rate of growth, appearance, etc. It is not desirable to delay bulling too long in this country since it may lead to sterility if the animals tend to become over fat. On the other hand, it should be remembered that the rate of growth and bone formation is greatly slowed up once an animal is in-calf. Generally speaking, 20 to 24 months of age is a suitable figure for Kenya conditions; in the highest-altitude areas, this age limit may be extended to 30 months. Hand-reared calves generally breed more regularly and are easier to get in-calf than naturally reared stock.

Once again it is important to stress the fact that breeding and feeding policies must go hand in hand, and it is essential to feed female and bulling stock as better bulls are used. It is too common to see highly bred calves and heifers that have not received adequate feeding as youngsters and which have been permanently stunted in consequence.

A PEST OF CINCHONA

Growers of Cinchona would be well advised to keep a look out for a destructive pest that recently occurred at Amani. This is the caterpillar of the Oleander Hawk moth (*Deilephila nerii*), some 30 or 40 of which were found on young nursery plants of *C. succirubra*, though nearby plants of *C. ledgeriana* were not attacked. I have not found them on older trees established in the plantation, to which in any case damage would be less severe. The caterpillar, which is of the typical hawk-moth type, is green with a pair of conspicuous purplish "eye spots" towards the anterior end and a horn at its posterior extremity. They attain some three inches in length and when nearly full grown are extremely voracious, a single one being able to eat several of the large leaves of *C. succirubra* every day.

Contrary to local native opinion, they are quite harmless and may be handled with impunity.

Picking them off by hand is no doubt the simplest way of dealing with them. It may be mentioned that according to a recent catalogue of a London dealer in natural history specimens, Oleander Hawk moths are priced at 5/6d. each. If this is their real market value, I have recently been guilty of treading on some £10 worth of valuable bugs, but it is unlikely that any dealer would actually offer more than a few pence each, and that only for perfect well-set specimens.

T.W.K.

A VERMIN-PROOF POULTRY LOFT

By H. E. Emson, Senior Assistant Live Stock Officer, Tanganyika Territory

Only a small percentage of farmers in East Africa specialize in intensive poultry farming, but on most farms a few fowls are kept for household use.

These fowls are usually indifferently housed and are subject to frequent ravages by *kicheche*[1] and other vermin. A plan is appended of a vermin-proof poultry loft which is easily constructed and well within the means of most East African farmers. This is essentially a design for the farmer and is not meant for the poultry specialist.

The poles used should be hardwood, if obtainable, and the main posts should be treated with tar or some other wood preservative to prevent attack by ants. The height of the loft from the ground should be at least 6 ft., and preferably 8 ft., which will make it quite impossible for wild cat or other vermin to reach it by springing from the ground. From the ground level up to the floor of the loft the posts should be bound with flattened petrol tins, or other similar metal sheeting, starting from the bottom and making each subsequent sheet slightly overlap the one immediately below. This will prevent any animal from obtaining a foothold for climbing the posts. The loft can be constructed of ordinary round poles of about 3 in. in diameter; the sides should be covered with 1½ in. mesh wire-netting and the floor with ½ in. to 1 in. mesh wire-netting.

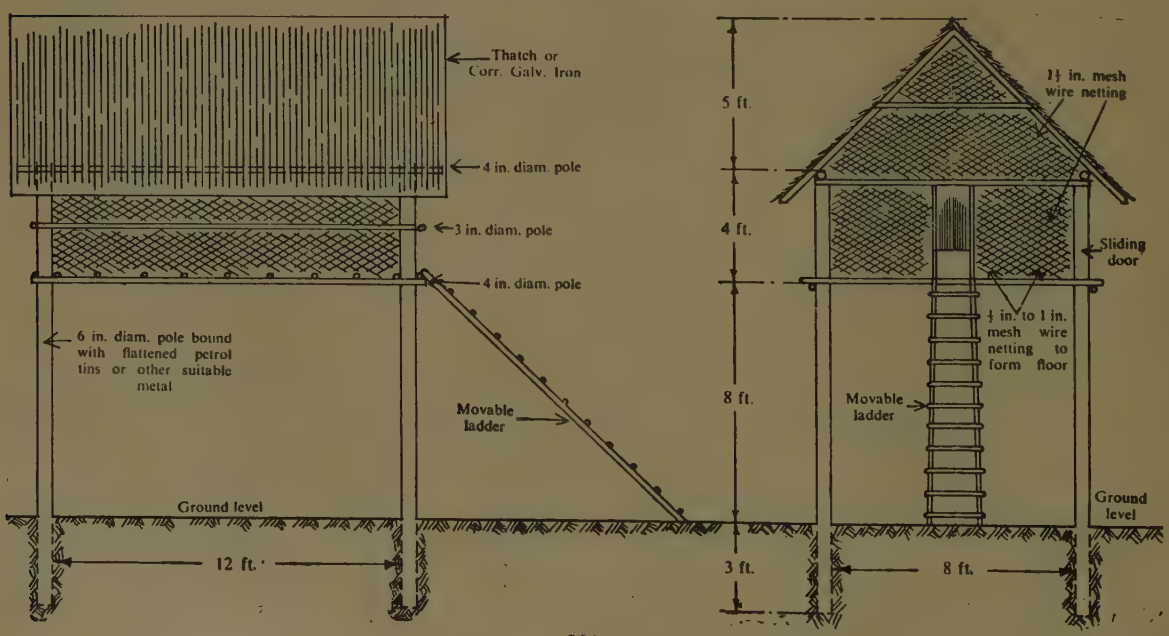
The smaller mesh for the floor is for increased strength to withstand the weight of the birds. The roof can be of corrugated galvanized iron, or of thatch. If thought necessary, perches can be fixed across the loft, but it will be found that fowls will sleep quite comfortably on a wire-netted floor.

The ladder leading up to the loft should be strong enough to withstand the weight of a man, to enable him to close the fowls in at night. It should be taken away every night as soon as the fowls have gone to roost, and replaced in the morning.

With the wire-netted floor, the droppings will of course accumulate on the ground. They should be removed every few days to prevent flies from breeding. Fowl droppings are of high manurial value, and should be added to the compost or farmyard-manure heap.

The type of poultry loft described is purely for the protection of the birds at night. No provision has been made for nesting-boxes. These can either be placed in outbuildings, such as implement sheds, or in a shelter constructed near the loft.

[1] *Kicheche*=a small carnivore—but as to whether cat or mongoose, see a note by T.W.K. in the editorial columns of our November (1939) issue, p. 164.



AN INGENIOUS NATIVE CHICKEN HOUSE

By C. G. Glegg, Agricultural Assistant, Shinyanga, Tanganyika Territory

An interesting native chicken house, as illustrated, was seen in the Nindo Chiefdom of Shinyanga District. Its construction is extremely simple yet effective.

It is made with a framework of bush withies which are thatched over with grass. A circle of pliable withies, four feet in diameter, is pegged in position on the ground and a cone-shaped framework is then built on to it, the apex being some five feet from the base. Lengths of withies are tied across the bottom of the framework with gaps between each to allow the droppings from the birds to fall through to the ground below.

The framework is then thatched in the local way and a small doorway is left. The door consists of plaited withies, and is held in position by a string loop and stick.

The completed house is hung from bush timbers, the base being approximately five feet from the ground, and the birds enter and leave the house by a simple ladder of sticks.

AVOCADO CULTURE

The following is extracted from an article by F. G. Galang in The Philippine Journal of Agriculture, *Vol. IX, No. 3, pp.* 315-325, 1938. *Some notes by F. M. Rogers, Superintendent of Plantations, Amani, have been added.*

In planting avocado, one of the most perplexing problems is the choice of the right varieties, and this is due to a considerable variation in the productiveness of avocado trees. Some trees profitably bear fruits every year; others only in alternate years; others do not bear any fruit at all. Many varieties fail to bear fruits satisfactorily owing to lack of pollination brought about by the failure of the flowers to open at the proper time or to the incompatibility of the pollen itself. Generally, fruit-bearing in avocado will be more successful if compatible varieties are interplanted and if their flowers open at such time as will permit cross-pollination, or if self-compatible varieties are planted, the opening periods of flowers overlap. However, the varieties to be interplanted should have approximately the same flowering time—early varieties should not be interplanted with late varieties, and vice versa. The mid-season varieties can be interplanted with either the early or late varieties.

When selecting the varieties to be planted one should be guided by the following points: The trees should be hardy, productive, regularly bearing, disease- and pest-resistant, early- or late-bearing; the fruit should be of good flavour, quality and size; and the seed should be comparatively small. It should be borne in mind that the fat content does not indicate a good quality, for in the United States the most prized varieties are poor in this respect.[1]

The avocado is distinctly tropical and sub-tropical in its requirements. In localities where the dry season is not too long they thrive with very little attention. However, when the dry season extends to four or five months, they require some irrigation unless the soil moisture is within the reach of the roots during the driest part of the year.

The tree is not exacting in its soil requirements so long as good drainage is afforded. It is very intolerant of standing water and cannot endure it for any length of time. A deep and well-drained soil which is rich in organic matter is the best for avocado, but well-drained heavy soil of average fertility will also grow good avocado, especially in moist regions. Any soil where citrus trees thrive will produce good avocado trees.

Like most other fruit trees, the avocado does not thrive well in places exposed to strong winds. Its leaves cannot quite resist excessively hot, dry winds. Besides, winds increase the evaporation of water, which in turn may cause a heavy dropping off of immature fruits. Also the fruits are liable to suffer injury through rubbing against the branches or against each other, and the danger of the breakage of limbs, especially those heavily loaded with fruits, is increased. This is not, however, a limiting factor in avocado culture, because it can be remedied by planting windbreaks in places where there is no natural protection from winds.

The avocado is propagated by seeds, by budding, grafting, inarching, or marcotting, but preferably by budding and grafting. Inarching and marcotting are too laborious and expensive. Grafting sometimes gives better results than budding. The grafted plants are often more

[1] At Amani two varieties are outstanding, both of which fruit regularly and are excellent in size and flavour.—F.M.R.

vigorous than the budded ones. On the other hand, trees grown from seeds usually do not come true to type. The chances of obtaining a fruit of better quality than that produced by the parent tree are very small. It is the experience of avocado growers that seeds are unreliable means of reproducing a variety. If seeds have to be depended upon for the propagation of avocado, the seed of some avocado varieties may be carefully halved so as to produce two plants from each seed. The resulting plants should be given a reasonable dose of fertilizer in order to produce good growth. Generally, the whole seed germinates earlier, and the resulting seedling is more stocky and has more leaves than the halved seed.

The first step in the production of budded or grafted trees is the raising of the stock plants.[1]

As the seed of the avocado loses its vitality quickly, it should be planted while it is still fresh. If the seeds cannot be planted at once they should be stored in properly moistened sand, sawdust, charcoal or sphagnum moss. The seeds may be planted directly in bamboo pots or in seed beds with the pointed end up. About one-fourth of the seed should be left exposed, so that the resulting sprouts can be thinned out, leaving the strongest one. The seeds are set 40 or 50 cm. apart in the seed beds. In potting, the soil should contain one-third each of sand, loam, and well-rotted compost. If sown in seed beds the soil need not be so rich—a sandy loam soil being sufficient. It is sometimes advisable to grow the seedlings for budding or grafting in the seed beds, although it will require more labour to remove them properly when transplanting them in the field. Seeds should not be allowed to dry out, otherwise they will lose their viability.

Budding or grafting[2] is done in the same way as in citrus or other fruit trees. It can be done any time the stem of the stock plants has become a little larger than a lead pencil, provided it is not raining and that the seedlings are in condition; that is, the sap is flowing freely. The scion should be selected from the best tree of the desired variety, should be well matured, preferably from twigs which are just ready to send out new growth, and should contain plump and well-developed buds.

Avocado stem is very brittle, so that in forcing the bud to grow a notch should be made a few inches above the bud, instead of cutting the stem halfway into the wood of the stock for lopping, as in the case of other fruit trees. In lopping never bend the stock as in other fruit trees in order to avoid a premature breaking. When the scion is already well advanced, the top of the stock may be cut off entirely about 10 cm. from the bud. After the bud has grown to a length of about 25 cm. the stock should be cut off clean just above the union of the stock and the scion, and the cut surface should immediately be painted with white lead or other suitable materials. This will protect the wood from decay.

1 Stock plants are usually raised from seed. The varieties used for stocks should, as far as possible, be selected from vigorous types that are known to suit the locality in which the grafted trees are to be grown.—F.M.R.

2 Budding consists of cutting out an eye or bud of the scion with a portion of bark attached and inserting it in a slit made in the bark of the stock.

Grafting.—One of the most successful grafting methods adopted at Amani is that known as "wedge" grafting. The top of the seedling stock is cut off and split. The scion is then cut to a wedge shape and inserted in the slit. Great care must be taken that at least one side of the inner barks of stock and scion come in contact with each other.—F.M.R.

When the plants are about 50 cm. high or more, they can be transplanted in the field at the beginning of the rainy season, at a distance of about 8 to 10 metres apart in holes large enough to accommodate the plants. Set the plants as deep as they grow in the nursery, and use good surface soil for refilling the holes. The soil should be packed firmly around the plant.

As a general rule, avocado requires little or no pruning at all after the tree is properly established. The pruning of forking branches and shortening of young and spindling twigs may be done to strengthen the stock and the framework of the growing tree. This is to be done at their dormant stage. The mere pinching of undesirable shoots may induce the growth of other buds where an extension is needed in order to make the trees more or less symmetrical in growth. Tall growing trees should be pinched back. Again, some thinning of the branches should be done from time to time so as to permit sunlight into the inside foliage. Of course, any heavy pruning should be avoided, as this will greatly accelerate vegetative growth and delay the fruiting period. Only dead and undesirable branches should be removed after the fruits have been harvested. All wounds should be painted with white lead or other suitable materials to avoid rotting.

It is often advisable to top-work undesirable trees in the orchard to a good variety. This can be done by cutting the tops back, including the big branches. Of the numerous sprouts which appear, only a few good ones should be left for budding or grafting with selected scions. The cut surfaces and the trunk should be painted and whitewashed in order to protect them from decay and sunburn.

Avocado trees grown from seedlings begin to bear fruits when about four to eight years old, six being the average. On the other hand, vegetatively grown trees sometimes begin to bear fruit the first year in the nursery. At this age, however, and probably up to three years, they should not be allowed to fruit. The annual yield of a full-bearing tree ranges from a few to 500 fruits; sometimes from 800 to 1,200 fruits. An average of 500 fruits a year per tree is considered a fair yield. Generally, the yield varies from one season to the next, partly depending upon the size of the previous crop, rainfall, winds, and the conditions of the tree at the flowering season.

A LATE SURVIVAL OF THE DIGGING-STICK IN KENYA

Mr. M. H. Grieve, Agricultural Officer at Machakos, writes:—

The Wakamba were originally mainly a pastoral folk with some leanings towards agriculture. Until quite recently new land to be brought under cultivation was cleared by burning, and the soft rooty earth was easily turned over with large wooden digging-sticks called *nthii*. These sticks were 5 to 6 ft. long and about 2½ to 3 inches in diameter, with a pointed flattened end for digging. The blade was driven into the ground and the earth levered over by the long shaft, using both hands. The poles used for making the sticks were of *Acacia mellifera* (*muthiia*) or *Olea chrysophylla* (*muthata*).

For cultivating land already broken in, a smaller digging-stick was used. Such sticks (*mio*) were 3 to 4 ft. long with a flattened end like the others. They were not nearly so heavy and could be wielded more quickly, being intended for light land; they were gripped in one hand only.

An adaptation of the smaller stick is in common use to-day for planting seed and for inter-crop cultivation, but is shod with an iron spear-head.

STRIP CROPPING

By Colin Maher, M.A., Dip. Agric. (Cantab.), A.I.C.T.A., Officer in Charge, Soil Conservation Service, Department of Agriculture, Kenya Colony

Many people are vague about the functions of broad base terraces, beyond a general idea that terraces are supposed to stop erosion.

The primary purposes of terraces are to hold up run-off water in order to promote absorption, and to prevent the run-off water on a slope from collecting in sufficient quantity and with enough velocity to exert eroding power. The excess run-off water from successive portions of a slope is led off along gently graded channels, so that it may be disposed of harmlessly and without damage to arable or pastoral lands.

It is *not* the intention of broad base terracing to lead to the formation of a series of large benches on the field, though this may happen owing to wrong construction, very steep slopes, faulty maintenance, rainfall with a high intensity, and a non-porous soil.

Broad base terraces on reasonably gentle slopes, up to 10 or 12 per cent, should not tend to build into bench terraces—or at any rate the tendency should be almost imperceptible in 60 or 80 years—if the maintenance by ploughing is carried out correctly and if appropriate farming methods are adopted. The general plan is to make every drop of water soak into the land where it falls, and therefore to ensure that the top soil remains in its original position, even if the land is sloping. Soil which is on a slope is not necessarily unstable if circumstances are not unfavourable, and marked downward movement of soil, although accepted and controlled when level contour banks, walls or live wash stops are being used, must generally be considered as dangerous and unnecessary.

If "benching" is occurring rapidly, it means that far too much water is moving downhill and being lost, and the danger is indicated of future breakages in the benched terrace system by gullying. Strip cropping gives great assistance to a system of terraces, by checking the water, encouraging the absorption of run-off, and filtering out silt which would otherwise clog the terrace channels. Strip-cropping is a method of planting close-growing hay or grain crops on the contour, alternately with contour-planted row crops, and is much used as a soil conservation measure in the United States; but it has yet to come into use in European or native areas in East Africa.

In steeply rolling areas, where terraces are not favoured owing to their expense, strip cropping is sometimes used as a soil conservation measure apart from terracing. This possibility is limited, however, to areas in which the soil is very porous and the rains do not have too high an intensity. Reliance on strip cropping, where conditions are not suitable, may lead to disaster; except on small catchment areas with a porous soil, or on gentle slopes up to about 2 per cent, strip cropping should be regarded as an ally of terracing, not as a rival. Mr. C. R. Enlow, head of the Section of Agronomy and Range Management, Soil Conservation Service, Washington, wrote in the January, 1939, number of *Soil Conservation*: "The agronomist who is willing to recommend contour strip cropping to control erosion on a long, badly eroded slope with a distinct erosion pattern already established and the topsoil mostly gone, is being too confident about something he does not understand."

Strip crops, by filtering out sediment from run-off water, are apt to produce a benching effect, and although the soil is being "kept on the farm" the subsequent management of these benches, if they become too exaggerated, may be a little difficult.

It is essential, of course, that the strips shall be planted fairly accurately on the contour, and that the edge of the strip shall be kept year by year by throwing a furrow outwards each way in order to mark the line. In the United States permanent strips of grass are often planted to cover a terrace bank or channel. An extra portion may be planted to include the irregular portion of land which would be planted with short rows; thus a band of uniform width is left for planting with row crops.

Alternatively, strips may be planted in between the terrace lines to break the run of the slope from terrace to terrace; or just above the channel, in order to remove silt from run-off water about to enter the channel. Yet again the contour strips may be treated as separate fields for use in a rotational system. In the latter case the strips will be approximately equal in width. Experiment is needed to determine the appropriate distance apart and width of the strips.

In Ohio, strips are placed 60 ft. apart on 14 per cent slopes, and 42 ft. apart on 20 per cent slopes. In Nebraska, Kansas and Oklahoma, the following intervals are recommended: "(*a*) Slopes 0 to 2 per cent: Minimum of 25 to 50 feet in erosion-resisting crops and 100 to 150 feet maximum in row crops. (*b*) Slopes 2 to 3 per cent: Minimum of 40 to 50 feet in erosion-resisting crops and 75 to 125 feet maximum in row crops. (*c*) Slopes too steep for terraces: Fifty per cent of the land area should be in a permanent or semi-permanent erosion-resistant crop. The clean tilled strip should not exceed 100 feet in width."

Frequent narrow strips are more effective than wide strips placed far apart.

Diversion ditches are necessary above strip-cropped fields that are liable to receive run-off from above.

Difficulties in the use of strip cropping in East Africa arise from the fact that annual grain crops which might be used for strip cropping are removed from the ground before the commencement of the rains, when erosion is likely to be most intense. This virtually limits the choice of strip crops to permanent hay or forage crops, although close-growing annual crops might be planted on the contour, as supplementary strips, during the growing season.

Sweet potatoes have been used for contour strips in native areas, but they have the objection that the growers are likely to have removed the potatoes, and spoilt the effectiveness of the strip for erosion control, just before the occurrence of heavy rain.

In some cases difficulty might be found in pasturing meadow strips when intertilled crops are growing in between. This difficulty could be overcome in European areas by the use of the single-strand electric fence, which can be readily removed and erected elsewhere, where this fence is successful.

Strip cropping is likely to have a value in the native reserves chiefly in those densely populated areas in which the preservation of special areas for grazing, hay or forage crops is most urgent. Even so, especially if the meadow strips are grazed hard, the need for a water-disposal system is not likely to be obviated except under certain fortunate and special circumstances.

TROUT IN KENYA COLONY

PART I—BROWN TROUT

By Hugh Copley, Assistant Game Warden, Kenya Colony

There is no need to apologize for writing an account of "Trout in Kenya Colony," for so many are interested in this subject, not only in Kenya, but also anglers in other colonies into which trout have been introduced.

Much research will have to be undertaken before all the interrelated facts are understood, but enough is now known to make possible a preliminary survey of the whole subject. S. F. Bush has stated, with regard to the introduction of trout to Natal: "The successful establishment of trout in a new environment or the improvement of the trout stock of any environment will depend on the establishment of a perfectly balanced equilibrium between the trout population and its environment."[1] Exactly the same can be said of Kenya. Therefore this examination will deal firstly with the rivers and then show how environment has affected the original stocking and their offspring. As the reaction of the brown trout and the so-called rainbow trout to their environment has been different, this examination will be divided into two distinct parts.

It was quite natural that the early European pioneers of settlement in the highlands should have considered the introduction of trout into the hill streams. They looked "trouty". The lead was taken by Major Grogan, and in 1905 Loch Leven stock was introduced. The ova was hatched out in the Gura River at an altitude of 9,500 ft. A fishing association was formed; but the trout were generally left to look after themselves until, in 1912, the then Game Warden, Captain Woosnam, persuaded the Government of Kenya to take over trout culture. This work was put under the charge of the Forest Department.

From the outbreak of war till 1919 no interest was taken in the trout, but in that year the whole matter was revived at a public meeting, and as a result of that meeting the East African Angling Association was formed. The first consignment of ova was a present from Sir Charles Ross, and 100,000 ova was received, yielding 5,000 fry.

The East African Angling Association became the Kenya Angling Association in 1923. Even under a new name matters did not improve, for the whole business was far too big to be handled by a private association. An appeal was therefore made to Government.

In 1925 it was evident that Government would have to take over trout fishing. This was done in 1926, when trout fishing became a ward of the Game Department with an Assistant Game Warden in charge (Captain R. E. Dent). In 1927 a new Ordinance, dealing solely with trout, was passed into law, and in 1937 an Advisory Trout Board was formed to advise the Game Warden on all matters connected with trout.

Various importations of eyed ova were made from time to time, the last being in 1934.

To show the great increase made with stocking rivers, it may be mentioned that in 1925 there were 150 miles of stocked water on European-owned lands; in native reserves, 67 miles; on Crown lands,

1 *The Establishment and Well-being of Trout in Natal Streams,* S. F. Bush, 1933.

164 miles; a total of 381 miles of trout water. In 1939 there were 1,026 miles in forest areas (Crown lands), 494 miles in native reserves, 299 miles on European-owned lands, with 120 miles of water controlled by angling clubs and associations. This makes a total of 2,039 miles of water stocked with trout, and it is being added to every year. Of this total there are 373 miles, or 18 per cent, of brown trout water.

The main rivers stocked with brown trout are as follows: The Thika Chania, Maragua, Gura, Northern and Southern Mathioya, and the Nyeri Chania. These rivers all rise on the Aberdare range and flow down its eastern slopes into the Athi and the Tana river system.

The ova imported has been straight brown trout, or the so-called Loch Levens. I say "so-called" for Loch Leven trout are of course only brown showing individual variation as a result of environment. In Kenya this variation disappears, and whatever the stock the result is a typical brown trout.

Description of the Brown Trout Rivers

Geology.—The brown trout rivers all have the same geology, and Fig. 1 shows a cross-section of the Aberdare range, roughly along the path from Naivasha to Nyeri. This diagram is taken from *The Rift Valley and Geology of East Africa,* by Professor Gregory. The geology of the Nyeri Chania is typical of the others, so will be considered as the type.

The sources of the Chania on Mount Sattima are on phonolitoid-kenyte, and there are only traces of an upper river bed. The erosion is less on the moorland section than further down-stream. At the eastern rim there seems to be a series of faulting, over which the waters of the Karura, Nyeri Chania, Amboni, the Mathioyas, and the Gura all fall in a single leap of from 200 to 250 feet. This faulting is not shown on the diagram. The river then runs in a very deep gorge until it falls over another fault (also common to the other rivers), about four miles from the forest line. From there onwards there are no high falls. It seems that from the falls at the eastern rim down-stream the river has cut through the phonolitoid-kenyte to the underlying basalt. The headwaters flowing on the phonolitoid-kenyte should give an acid pH reaction, and this should also be augmented by the flora of the moorlands, but as soon as the bamboo section is reached, below the high falls of the eastern rim, the river, having worn through the phonolitoid-kenyte to the basalt, should become alkaline. A series of pH readings, taken from 9,500 feet altitude to 4,500 feet shows a gradual increase from 5.8 to 8.2.

General Characteristics of the Rivers.—The slopes of the eastern side of the Aberdare range are more gradual than those of the western side. They rise to an altitude of 9,750 ft. and then fall inwards forming two basins at an altitude of 9,500 ft. (Fig. 2). Out of these basins rise two peaks (Kinangop, 12,815 ft., and Sattima, 13,003 ft.). These basins are healthy moorlands, and there is another zone of high moorland around each peak at an altitude of 11,000 ft.

The tiny headwaters of the Gura, Maragua, and Mathioya have their beginnings on the slopes of Kinangop, whilst those of the Chania and the Amboni are on Sattima. These basins are the main reservoirs for the two periods of rain, storing them up and passing the accumulated water to the streams. In the basins, the rivers are quite large, 12 ft. to 15 ft. across, with luxurious beds of water weeds and marginal plants. These stretches support trout in abundance.

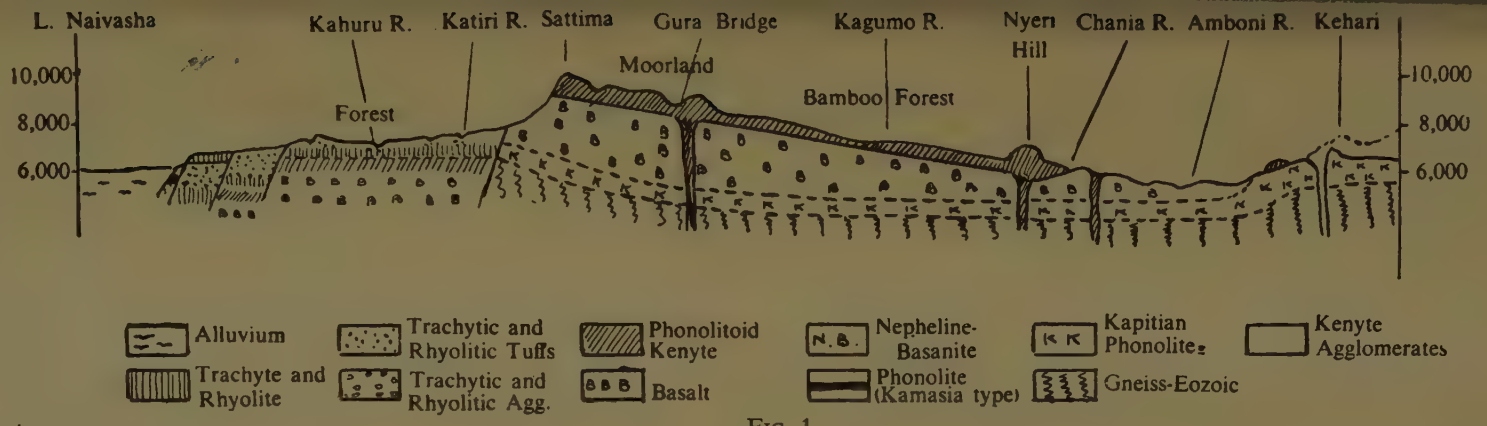


FIG. 1

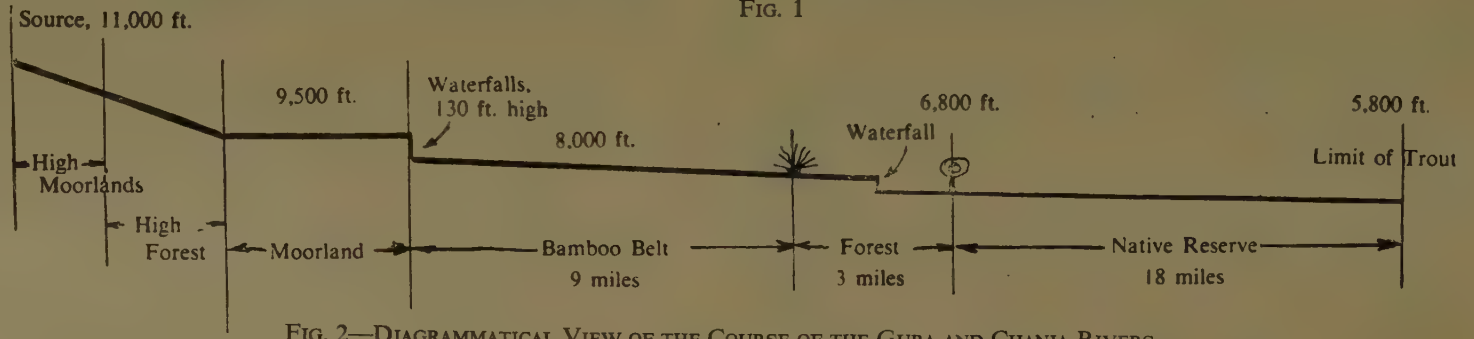


FIG. 2—DIAGRAMMATICAL VIEW OF THE COURSE OF THE GURA AND CHANIA RIVERS

FIG. 3—CROSS-SECTION OF CHANIA RIVER AT 9,500 FT., SHOWING UNDERWATER AND MARGINAL FLORA

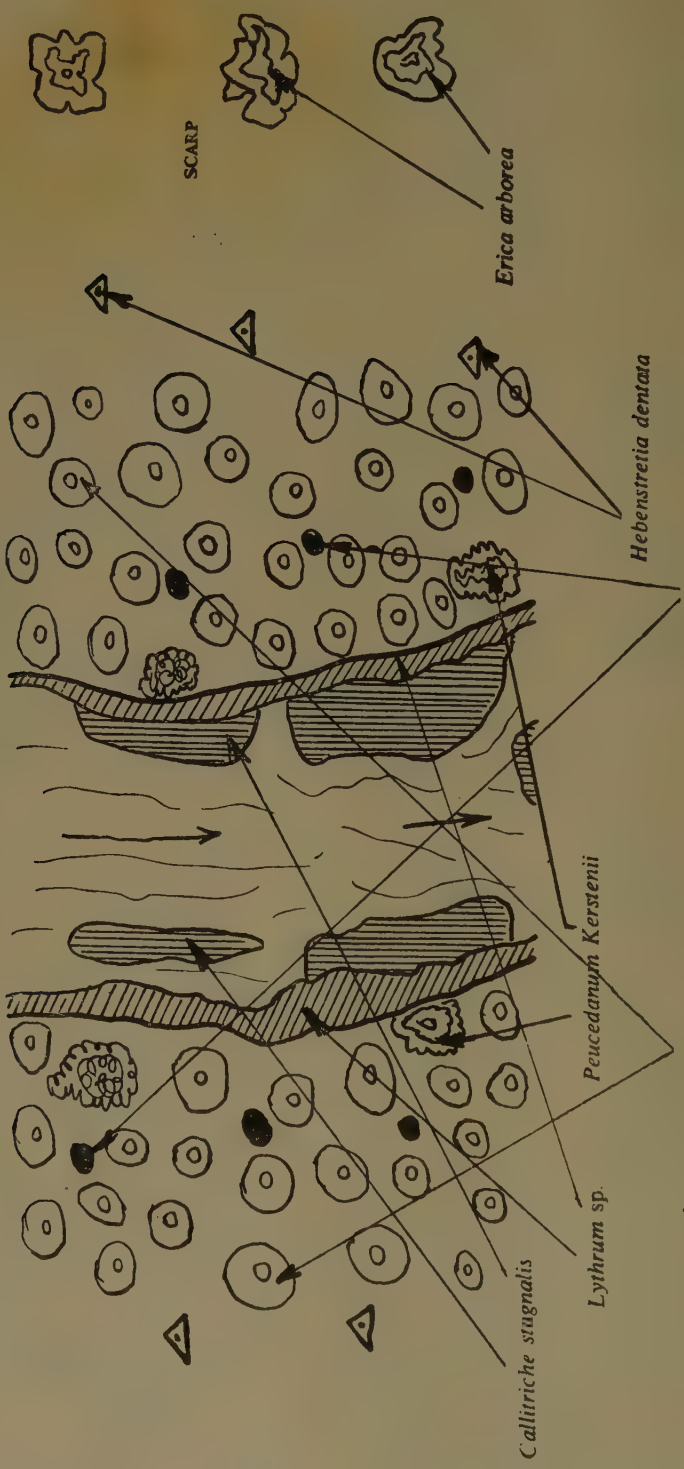


FIG. 4—PLAN OF CHANIA RIVER, SHOWING UNDERWATER AND MARGINAL FLORA

The rivers then break through the rim of the eastern edge in high waterfalls and flow through the great bamboo belt, which is from 9 to 12 miles in depth. The course of each river through this bamboo belt is a series of stretches of fast white water, with holding places behind great boulders; the river is still being fed by the very considerable seepage from the ground underneath the bamboos. The river then enters the fringing forest belt at approximately 8,000 ft. Here pools begin to appear, until the edge of the forest is reached at 6,800 ft. From this line on through the native reserves the river is a series of rapids and pools. The plains are reached at 5,200 ft., when long, still reachers occur; and from there onwards the place of the trout is taken by indigenous fish (Barbus, Labeo and Siluridae).

Flora (Underwater and Marginal).—Two examples will be taken, one across the river in the low moorland at 9,500 ft. and the other at 6,200 ft. Figures 3 and 4 show a cross-section of the river and a plan of the same place. It will be seen from the cross-section that parallel to the river on both sides there is a small rocky scarp which is the old river bed. This is covered with grass and a heath, *Erica arborea,* with small bogs in its low-lying pockets.

From the bottom of the scarp to the water edge the dominant shrub is *Anthospermum usambarense,* with patches of a Club moss, *Lycopodium clavatum.* These plants harbour all kinds of terrestial trout food, much the same as heather does in Scotland. Here and there are stands of *Alchemilla argyrophylla,* and growing on the edge of the river banks are clumps of a wild parsley, *Peucedanum Kerstenii.* From the top of the banks to the water edge and even in the water, the river is lined with *Lythrum,* and this forms an excellent harbourage for terrestial insects and a suitable anchorage on which the mayflies can undergo their metamorphosis. On seeing this part of the river for the first time the eye of the angler will be immediately drawn to the bright green beds of water starwort, *Callitriche stagnalis,* growing under the clear water. No Itchen or Test can produce such glorious beds of this weed. These masses are packed full of underwater life, including numbers of dragonfly nymphs.

Figure 5 shows a plan of the marginal plants at 6,000 to 6,200 ft. It will be noticed that the big clumps of underwater weeds are replaced by boulders with moss.

At the water edge are two kinds of *Crassula,* especially *Crassula Wrightiana.* These harbour all kinds of insects. These plants are sometimes even more in the water than at the place chosen as an example.

At one spot the handsome *Hibiscus diversifolius* stands above the vegetation and immediately catches the eye. The other semi-aquatic plant is the pink-flowered *Polygonum barbatum.* This is the most common of the marginal plants down-stream from the forest line. In some districts a white flowering variety is found instead of the red.[1]

The rest of the plants do not interest the fisherman except when they catch his fly on the back cast.

Temperatures.—It is essential to realize the great daily variation in the air and water temperatures. The charts, Figs. 6 and 7 give air and water readings at 6,500 ft. and at 9,500 ft., whilst Fig. 8 gives air and water readings showing the effects of a flood at 6,500 ft. In this latter diagram it will be noticed how the peak

1 I am indebted to P. R. O. Bally, Esq., of the Coryndon Museum, for identification of the botanical specimens.

FIG. 5

PLAN OF THE RIVER AT 6,000 FT., SHOWING MARGINAL PLANTS

A—*Lindernia Whytei*
B—*Heliotropum indicum*
C—*Polygonum barbatum*
D—*Crassula Wrightiana*
E—*Crassula* sp.
F—*Pavonia schimperiana*
G—*Hibiscus diversifolius*
H—*Drymaria cordata*
I—*Oldenlandia herbacea*
J—*Pentas carnea*

water temperature has been flattened out. The shaded area on Figure 6 shows the time when the trout were on the feed, a period of low temperature from late evening to early morning.

Chemical Factors. — Although no chemical analyses have been made at various altitudes it can be assumed from the quick rate of flow of our trout streams that most of the carbon dioxide is very rapidly passed away into the air whilst fresh supplies of oxygen are dissolved into the water. The oxygen content of the water is usually more than sufficient for the trout. Readings of the hydrogen-ion concentration have been made, and an average would be 6.7 at 9,500 ft. and 7.8 at 6,500 ft. The first is slightly acid, as one would expect from the vegetation and geology of the low moorland.

Although trout are supposed to grow slowly and be short-lived in acid waters, yet a large number of trout in the 9,500-ft. zone grow well up to five pounds, but the majority there are definitely slow growers. No confident assertion, however, can be made that this is only due to the acidity, for the waters are definitely overstocked and slow growth may well be due to lack of food.

In the lower waters at 6,500 ft. the trout are definitely larger, but here overstocking is less evident, and is more in proportion with the food supplies of the river. Thus, although the pH of a stream may and doubtless does have a considerable direct effect on the rate of growth, it is probably not the only or even the most important condition that governs it.

Pollution.—So far none of the trout streams has suffered from pollution. It is not until 6,000 ft. is reached that there is any pollution from coffee factories, and below 5,500 ft. before there are any effects of pollution from sisal waste. These affect the indigenous fish only.

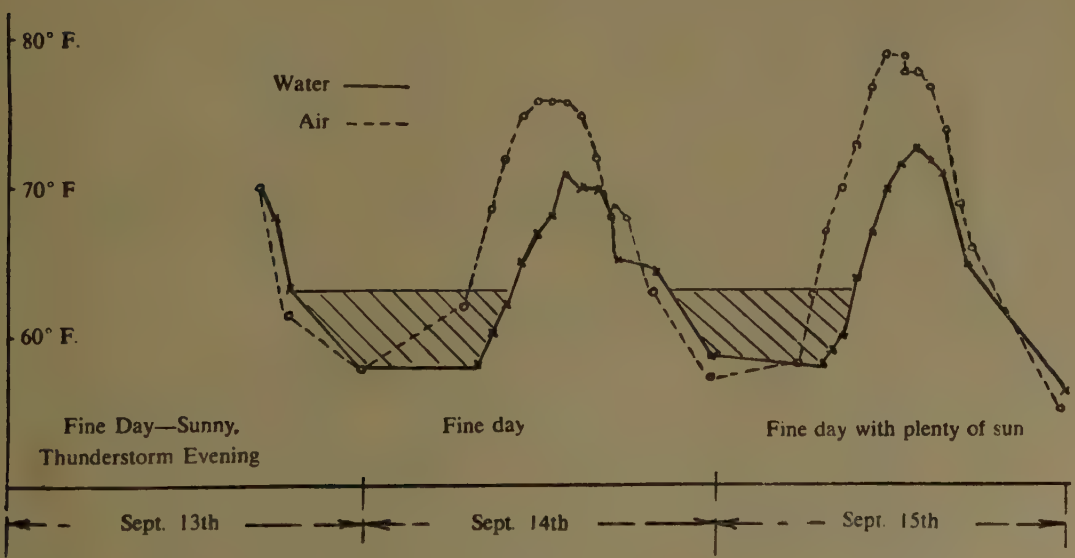


FIG. 6
AIR AND WATER TEMPERATURES, GURA RIVER.
Sept. 13th to 15th. Altitude 6,500 ft.

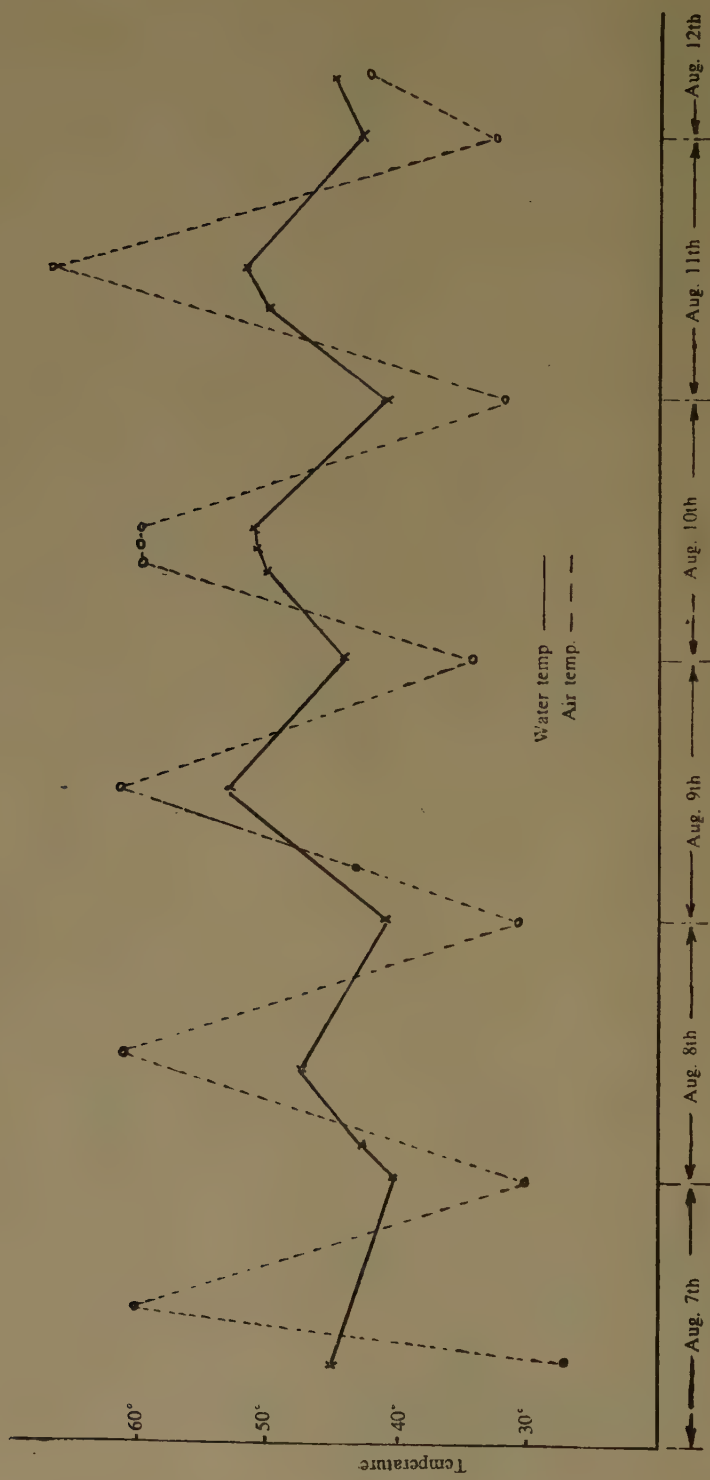


FIG. 7
AIR AND WATER TEMPERATURES, CHANIA RIVER.
Altitude 9,500 ft.

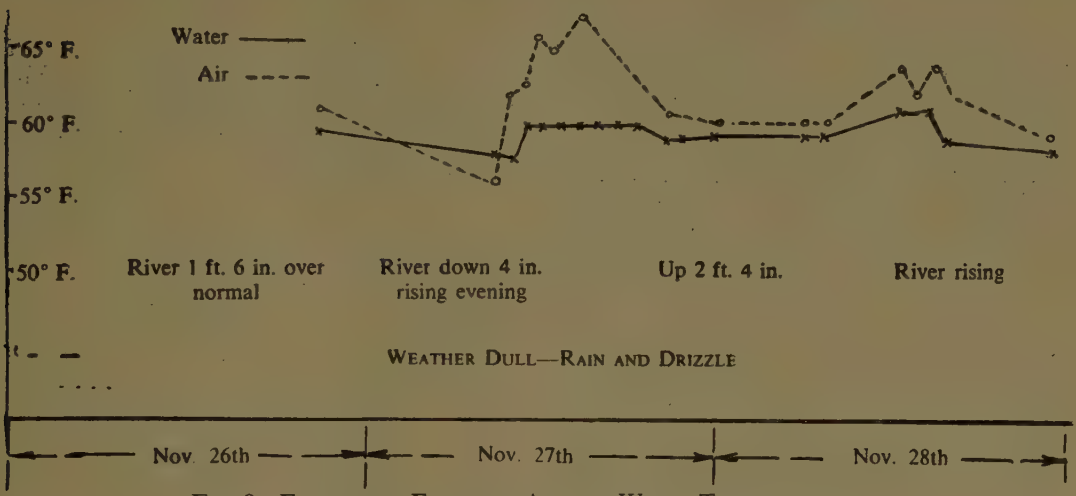


Fig. 8—Effects of Flood on Air and Water Temperatures
Nov. 26th to 28th. Altitude 6,500 ft.

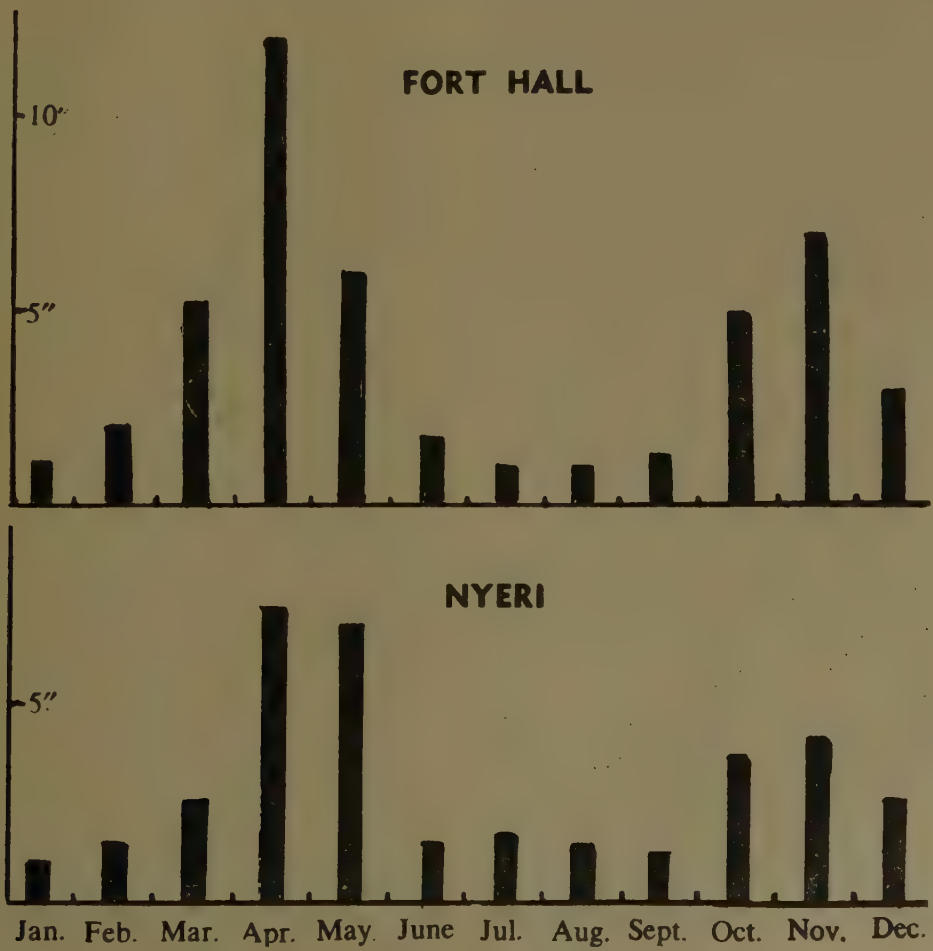


Fig. 9—Yearly Rainfalls in Inches: Brown Trout Rivers

Abstraction of Water.—All the headwaters of the brown trout streams are in the forest reserves, consequently there is no abstraction of water until the rivers leave the forest reserve boundaries. Then only a small amount is taken for crop production, and this is principally from the small tributaries. The main abstraction is for the purpose of driving crude stone maize-grinding mills, which is a paying business and an increasing one.

The procedure is to build a rough stone dam across the river and then to lead off a furrow to the mill. From the mill a lead is taken back into the river. As the native is bad at taking levels, several attempts are often made and abandoned before a proper flow is obtained. These rough stone dams simply act as a sieve to the river, but often attempts are made to stop the passage of the water through the dam by using grass sods on the up-stream face. The great danger of the dams is the stoppage of the fish down- or up-stream and also the stoppage in the migration of any underwater insects. As the provision of such mills is considered a legitimate part of the development of native enterprise, co-operative methods are being used. A survey is made by the Fish Warden, and if the site is considered favourable a fish pass is installed by Government when the dam is being built. Care is also taken to have the intake to the top flume properly screened. Permission is not given to erect any new works until these requirements are met.

When any dam or construction of a permanent nature for hydro-electric or other works affecting the flow of the river is planned, the lay-out is always considered by the Game Warden before being passed by the Water Board. The actual work is inspected to see that the plans have been carried out. This is the duty of the Fish Warden.

Biotic Factors

Scale Readings of Brown Trout.—The following are scale readings from the scales of large brown trout taken from various rivers:—

(*a*) River, Thika Chania

Weight .. .. 8 lb.
Sex .. .. .. Male
Dimensions .. .. 29″ × 14½″
Growth Rates:

Year				
1st	2nd	3rd	4th	5th
5¼″	16½″	19⅛″	22¼″	29″

Condition Factor .. 76

(*b*) Gura River, Found Dead—Spawnbound

Weight .. .. 10 lb.
Sex .. .. .. Female
Dimensions .. .. 28″ × 17½″
Growth Rates:

Year						
1st	2nd	3rd	4th	5th	6th	7th
3″	10¼″	15¾″	19″	23¼″	27″	28″

Condition Factor .. 106

(*c*) Southern Mathioya River

Weight .. .. 7 lb.
Sex .. .. .. Female
Dimensions .. .. 24¾″ length
Growth Rates:

Year			3 yrs. 5 mths.
1st	2nd	3rd	
7¾″	20½″	23¾″	24¾″

Condition Factor .. 108

Examples (*a*) and (*b*) are scales of big fish that have had a completely natural life, and show that the fish, after their

first year, migrated down-stream and put on heavy weights up to the third year in the lower and better feeding stretches of the river. After that the growth rate slows up and death comes about the seventh or eighth year.

Example (*c*) is of a fish caught at the end of the first year and taken down-stream about eight miles to the better feeding stretches of the river. This also shows the slowing up of the growth rate at the end of the third year.

Retention of the Ova.—This condition has been found in a number of big females, and always in the lower, hot water reaches. Specimens have been examined with three different growths of ova, representing three different potential spawnings, still retained in the abdominal cavity. The first two have been full sized and the third rudimentary. The ova had degenerated and would be useless if shed. The mass formed eventually causes death by pressing upon the pericardium and the heart. It seems that this condition is brought about by high water temperature upsetting metabolism. It may also be due to a lack of sexual excitement or of a suitable spawning ground. Whatever the cause, it is far more prevalent amongst the brown trout than the rainbows, and this leads one to think that high temperature is one of the contributing causes; although it may be that "the correct and necessary stimulus and incentive to spawn must be present, otherwise it is not possible for the female to pass the eggs."[1]

Breeding Seasons.—There are two breeding seasons—a major and a minor—during the year. The major one coincides with the long rains (April to June) and the minor breeding season is during the short rains (October to December) (Fig 9). It would seem that an influx of cold water stimulates the sex organs, more particularly those of the male. It is very noticeable that the brown trout seek the main stream, with a good depth of water, in which to make their "redds", whilst the rainbow run up the smallest of tributaries. The few experiments that have been made in the Colony show that the wild fish strip as easily as they do in the more temperate climates.

Enemies.—Brown trout were put into rivers devoid of any indigenous fish with the exception that, between 6,000 and 6,800 ft. there exists a small fish, *Amphilius grandis*. Two mammals frequented the streams—the clawless otter (*Aonyx capensis*) and the marsh mongoose (*Herpestes galera*. The main aquatic diet of these two mammals used to be frogs and crabs, and there is no doubt that the competition between them and the trout for the crabs reduced the number of the latter to such an extent that both mammals, the marsh mongoose especially, have been forced to take partially to a fish diet.

This was not recognized until a programme of otter-trapping was brought into effect on two rivers, when it was shown that not more than two brace of otters have their home on any one river. They have definite beats, and once the pair was trapped no more were taken, although numerous marsh mongooses remained and were trapped. The dung of both animals is very similar and generally contains the broken-up fragments of crab shells. The otter goes to the maize fields when the cobs are just forming, and there does a lot of damage. This gives the river a rest from two to three months each year, but the swamp mongoose spends his whole time by river or swamp; he is definitely a fish-eater, and when more is known of his habits it may be found that he is a far greater eater of fish than the

[1] D. S. Quale, Ballarat Fish Acclimatization Society, 1935.

otter. It is interesting to note that the remains of an eel were found which had been killed and eaten by an otter. This eel must have weighed a good 4 lb. when alive.

As soon as the brown trout descend to a level of 6,500 feet they are liable to be attacked by the spotted eel (*Anguilla labiata*), which grows to a weight of 24 lb. This is the limit of the up-stream penetration of this eel. Cases have been reported of trout up to 6 lb. having been attacked. As the eels feed at night, few fishermen know of their presence in a river or realize they are such a danger to the trout.

Another enemy is the Greater Kingfisher (*Megaceryle maxima maxima*). It is found in pairs, and each pair has a definite beat on the river from which they drive off any intruders. They are forest birds, living on small fish; thus they help to keep down overstocking.

The only other enemy to big trout is the poacher, and so far strict control of the best rivers has kept his activities within bounds.

Diseases of Trout.—In hatcheries brown trout are the subject of numerous diseases and parasites, but in the wild state this is fortunately not true. So far no brown trout suffering from any disease have been recorded. During the hot weather and in the lower stretches, dead trout have been found that have been reported as diseased. On examination it has been found that death has been due to an upset of metabolism brought about by high water temperature.

No Trematoda (flukes), Cestoda (tapeworms), Nematoda (threadworms) or Acanthocephala (spiny-headed worms) have been found in any brown trout. It is interesting to note that some trout living in the same pond as an indigenous fish (*Tilapia nigra*), infested with Nematode worms, were free of the infection.

Furunculosis is unknown, so are "pop-eye" and "fin rot". It is noteworthy that "pop-eye is most common amongst the tilapia of Lake Naivasha, but it has not spread into any of the trout streams. Saprolegnia has only been found once, on a specimen of the little top-water minnow (*Haplochilichthys antinorii*) in Lake Naivasha.

Food Supplies in the River

Before trout were introduced there is no doubt that the rivers had a most prolific underwater life, as samples from virgin waters show. It has been, however, a surprise to find that in waters overstocked with fish only certain types are eaten out, such as Trichoptera and Perlidae, whilst Ephemeridae (mayflies) still exist in great quantities. Fig. 10 shows the food from a virgin stream and also from one greatly overstocked with trout.

It is not yet known whether these latter types are distasteful to trout, or whether they escape as a result of their habit of clinging to the under-surfaces of stones. It is known, however, that the trout get the mayflies when they come to the surface to change to the sub-imago stage.

In the uppermost fast reaches of the river, 11,000 to 9,000 ft., there are two distinct types of food. The first is that found in the fast-running water, while the second is that of the slow-running flat reaches.

The first gives a typical stream collection consisting of Ephemeroptera (mayflies) of the families Ecdyonuridae, Baetidae, Leptophlebiidae and Caenidae (these form about 60 per cent of the whole); Trichoptera (caddis-flies), especially Hydropsychidae; Plecoptera (stone-flies), of the family Perlidae; Diptera (true flies), of the families Simuliidae (black-flies) and Chironomidae (midges), with Annelida of three families.

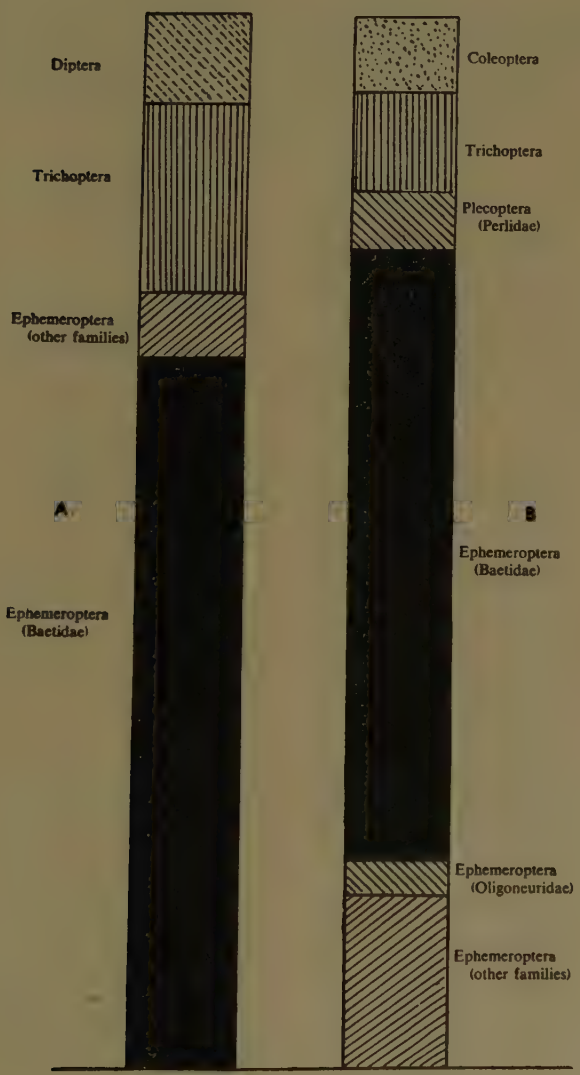


FIG. 10

A—Samples of underwater life—virgin river.

B—Ditto from overstocked river.

A collection of the second type consists practically all of nymphs of Odonata (dragon-flies) of the families Aeschnidae and Agrionidae.

The first type, i.e. from fast-running water, predominates until the river falls to about the 6,800 ft. level, and a typical sheet is as follows:—

Order	Family	Genus	Percentage of Species
Ephemeroptera	Baetidae	Baetis	8·2
,,	,,	Acentrella	3·2
,,	Ecdyonuridae	Afronurus	60·6
Plecoptera	Perlidae	Ochthopetina	1·6
Trichoptera	Leptoceridae	—	8·2
Odonata (Anisoptera)	Libellulidae	—	3·2
Diptera (Nematocera)	Simuliidae	Simulium	14·7

From 7,000 ft. downwards there is an increase in Libellulidae (dragon-fly) nymphs, and for three months in the year at an altitude below 6,000 ft. the big trout feed on nothing else.

Below 7,000 ft. Potamonidae (crabs) and the indigenous fish, *Amphilius grandis*, come more into the picture and are a large source of food. It is interesting to note that during the three months the trout are feeding on Libellulidae (dragon-fly) nymphs they will rarely touch crabs.

It is a curious fact that in Kenya waters any extensive simultaneous hatch of insects is almost unknown. Hatching takes place spasmodically all through the night; it is hardly ever seen in the day, and is usually very localized. A sparse hatch may go on intermittently on one reach while there is none on the next.

The chief months in which hatching takes place are from January to the end of March, and July, August, September and October. The hatch is greatest at full moon, increasing and decreasing with the phases.

What the Trout Eats

We have just discussed what trout food the river contains, and in Fig. 11 column A shows the result of the underwater stream examination and column B shows the contents of the stomachs of 48 fish, average weight a pound, caught the same day on the same stretch of water from which the underwater samples were taken.

It will be seen that column A shows to what a large extent the Ephemeroptera (mayflies) make up the food contents of the river, yet the stomach contents given in column B show that the Ephemeroptera were comparatively untouched.

This bears out the statement made that the trout either cannot get at the Ephemeroptera (mayflies) or that they do not like them. It will also be noticed that a lot of the food is of a terrestrial origin.

Finally, it may be mentioned that the remains of frogs, trout, rats and weaver birds have all been recovered from the stomachs of big trout.

Hybrids

Hybrids between the various Salmonidae have been bred under hatchery conditions for years, but comparatively few come to hand in the wild state.

From the Nyeri Chania many rumours were received of hybrids having been caught, yet it was not until August, 1938, that the first was received. A full report of this fish was published in *The Field*. Since then a number of these fish have been caught, nearly all of the same size and age. It seems therefore that, in this river at least, there has been a cross. The Game Department has been so impressed with these fish that some time ago a virgin stretch of water was selected having natural obstacles at each end which would stop the migration of the fish. This stretch was stocked with five male brown

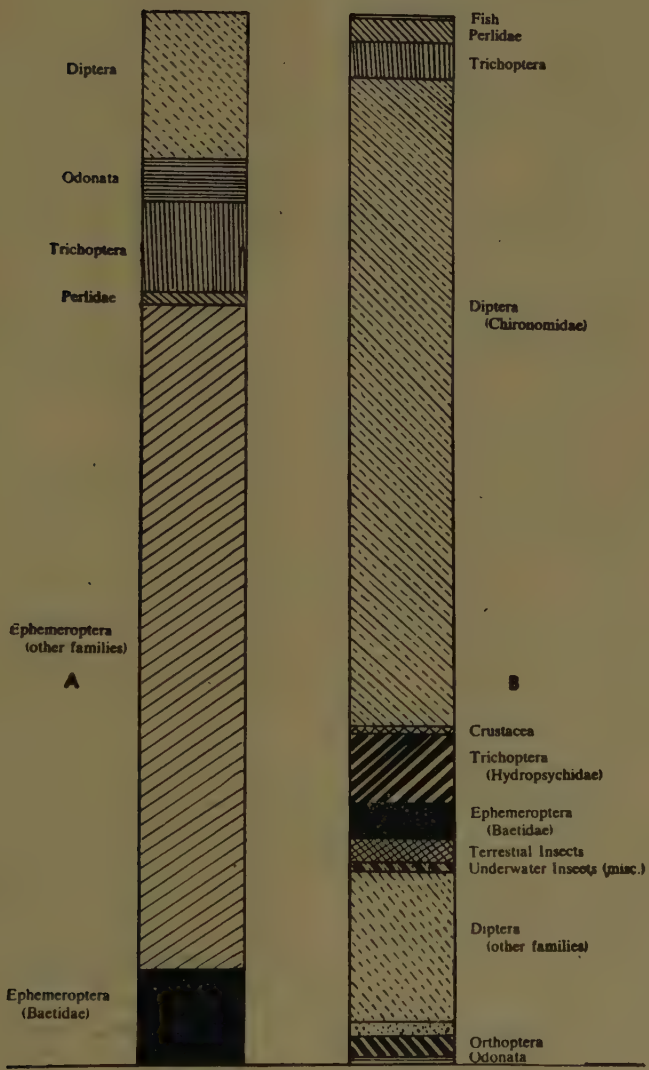


FIG. 11—THE FOOD OF GURA TROUT

A—Actual food in the river.

B—What 48 trout actually ate.

trout to every seven female rainbow trout, and the results will be carefully watched. It seems to be the case that these hybrids from the Nyeri Chania have definitely a higher condition factor than either the brown or the rainbow trout of the same age group; while it is clear that the first generation of hybrids is fertile in both sexes.

Stocking

In the past eyed ova has been shipped from an English hatchery to Kenya in the usual ice-cooled containers and then hatched out in modified Kashmir boxes. Brown trout ova has proved far more delicate during transit and the percentage of the hatch has been much lower than with rainbow trout. Native brown trout strip very easily, but no hatchery is needed to supply the needs of Kenya.

There are numerous rivers and streams that are overpopulated with trout, and it is far cheaper and more expeditious to transport fish from them to virgin streams. A routine has been developed for transportation, and the loss so far has only been one death per 500 fish transported.

This policy immediately calls forth protests from a school of thought that may be called "the interbreeders," who believe that trout deteriorate through over-breeding and inter-breeding, but that the introduction of a new strain from overseas will soon regain a larger individual weight and a better condition factor. This theory takes no account of the fact that a trout will increase in weight each year in the exact proportion to the amount of balanced food it consumes. In a hatchery the amount of balanced food necessary to grow a pound of flesh is accurately known, and a fish is fed accordingly; otherwise estimates of cost and selling prices could never be worked out. It is the same in nature. If the food and the other factors are not present the individual weights of the fish will suffer, and any new introduction of breeding stock only makes more mouths to feed and another drop in the average weights. Individual growth weights and condition factors depend on the amount of food available and the amount of food consumed, so long as the other conditions are all right. For instance, in April, 1938, three-year-old fish seven inches long were put into a virgin lake having suitable conditions and unlimited feed. These fish in May, 1939, were found to average just over two pounds. In another case fish have grown so fast that the scales hardly overlay each other. Gura fish moved from inside the forest section 14 miles downstream grew five ounces in four and a half months.

Effects of Environment on Brown Trout in Kenya

The main conditions in the environment that contribute to the well-being of trout and trout fishing are:—

(*a*) An ample supply of water, especially in the hot season.
(*b*) The pH and the chemical content of the water should be correct.
(*c*) The oxygenation of the water should be ample, especially during the hot months of the year.
(*d*) The calcium content of the underwater food should be sufficient.
(*e*) The underwater food should be ample and palatable.
(*f*) There should be no overstocking in certain reaches and understocking in others.
(*g*) There should be every facility for the trout to migrate up and down a river.
(*h*) Successful competition with the indigenous fish.
(*i*) Few enemies and these controlled.
(*j*) No disease.
(*k*) No pollution.
(*l*) Every facility for the angler to catch fish.

From the previous sections it will be seen that:—

(*a*) A constant volume of water is obtained from the low moorland and bamboo areas. These areas are at present forest reserves which cannot be ruined by cultivation, and as long as this is so the rivers are safe.

(*b*) As far as is known, the pH is suitable and from a study of the growth rates so also is the chemical content.

(*c*) Oxygenation is ample.

(*d*) The calcium content of the underwater life has not been estimated, and this should be done.

(*e*) At the time of the introduction of the brown trout the underwater food was ample, and even in overcrowded streams, as has been pointed out, certain types still exist in considerable numbers.

(*f*) There is definitely much overstocking in the higher reaches and understocking in the lower.

(*g*) This is impossible owing to the high falls at 9,500 ft., and also in the forest areas. In the lower reaches this is being provided for by cooperative efforts.

(*h*) This is not serious, since the indigenous fish do not go high enough up the rivers to compete with the trout for the available food.

(*i*) With the exception of the eel, these are easily kept in proper control.

(*j*) So far this has not been reported.

(*k*) No pollution has been reported high enough up-stream to affect the trout.

(*l*) This is being increasingly provided for every year.

It seems therefore that two main factors affect our brown trout and the sport they give to the angler: One is temperature, and the other is a lack of migration facilities up and down stream.

Extended experience with brown trout in Kenya points to the fact that it is a cold water fish and that this preference is hereditary. Therefore the brown trout will keep to the colder water and will not come down-stream unless driven by an absence of food. Brown trout regularly come down falls of 250 ft. safely, provided the film of water coming over the lip of the fall is deep enough to carry the fish into the pool below without harming it. The water coming over the fall must fall into a deep pool and not on to a mass of rocks. This means that migration can only occur during seasons of heavy rainfall and consequent heavy floods.

It is also a fact that the brown trout rivers of Kenya are the only ones that have in their upper reaches suitable cold water. During the past five years of low rainfall, floods have been insufficient for adequate migration. This is a serious matter, since it governs the extent to which the public can enjoy the sport of fishing. The forest, bamboo, low moorland and high moorland reaches are inaccessible to the fisherman. Upper sections must also be closed to protect the spawning fish. Thus it is in the lower waters that the public must fish, and in order that the fishing be good the fish must come down regularly from the overstocked breeding areas to the accessible lower stretches, where they can be fattened up and caught. The solution of the problem of how to aid this down-stream movement will be discussed in the last section of this paper under the heading of "The Future and a Policy."

DERRIS OR TUBA ROOT

A NOTE ON YIELD AND COST OF PRODUCTION IN EAST AFRICA

Active interest has been shown for some time past in the trials being carried out with *Derris elliptica* at the East African Agricultural Research Station, Amani, where a particularly toxic strain of this Malayan fish-poison and insecticide was introduced, via Kew, in 1928. It is now possible to give the yield and cost of production figures for the first normal crop of derris root harvested at Amani, the bulk of previous crops having been used for experimental purposes, or cut as planting material, for which there is a considerable demand in East Africa at present.

This crop was planted from stem cuttings of the so-called Amani strain of derris in 1936 and was dug in 1939 at the age of thirty to thirty-six months, the latter figure probably representing the optimum age for harvesting in this district which is three thousand feet[1] above sea-level and has an average annual rainfall of seventy-seven inches.

The sprouted stem-cuttings, raised in the nursery, were transplanted from their bamboo pots to the field at a distance of four by four feet, or 2,722 plants per acre. (Subsequent plantings have been made very much closer than this, and pots dispensed with.) The developing vines, which were not staked, covered the ground within fifteen months, so that maintenance operations after the first year consisted almost entirely of periodic weedings to remove bracken.

The crop was grown in poor, unmanured land, previously under native crops, on a fairly steep hillside.

The cost of production, under experimental conditions, amounted to Sh. 886 per acre, spread over three years, a figure that will be reduced considerably in future as the cost of establishing, per thousand plants, will be lower as the result of the simplification of nursery methods. Under non-experimental conditions cost of production should be still lower.

Cost of production (based on an average daily wage of sixty cents of a shilling):—

	Per acre
Cost of cuttings, 3,000 at 5 cts. each[2]	Sh. 150
Establishing crop, including preparation of land, raising cuttings, planting, etc.	Sh. 304
Maintenance, 1937	Sh. 140
Maintenance, 1938	Sh. 125
Maintenance, 1939 (part)	Sh. 50
Harvesting 2,722 plants at the rate of 14 plants per man-day	Sh. 117
Total cost per acre ..	Sh. 886

Yield.—The yield of air-dried root per plant from this crop amounted to 0.53 lb., or 1,443 lb. per acre, which can be regarded as satisfactory and up to expectation.

A sample analysis of the root after harvest gave a rotenone content of 9.05 per cent and ether extract 22.8 per cent, figures which support the past analyses of this strain and entitle the root to be ranked as high-grade derris.

[1] Equivalent, in mean temperature, to a considerably higher elevation in Kenya.

[2] These are charged at current price; the actual cost to a planter raising his own cuttings would be a fraction of this sum.

A trial consignment of this 1939 crop has been shipped to the U.S.A. for sale there, with a view to exploring the prospects for high-grade East African derris in that market. Last year's experimental crop from Amani, shipped as whole root in pressed bales, was sold in London at one shilling per lb., a price which would represent a profit of £28 per acre, after three years, assuming that the yield of root and the cost of production were the same as in the above trial. Prices on the London market in 1939 fell to considerably below one shilling per lb., unfortunately.

Apart from the return to be obtained from the roots, there is a ready local market at present for stem cuttings. A normal mature plant should produce fifty to sixty of these, in addition to its root.

Readers who are interested in this crop should refer to the following past numbers of the Journal in particular: Vol. I, No. 1, and Vol. II, No. 2.

A.G.H.

NOTE ON A METHOD OF RAISING SEEDLINGS FOR ARID DISTRICTS

By T. H. Jackson, Assistant Agricultural Officer, Kenya Colony

Trouble is often experienced in establishing seedling trees and shrubs in arid districts, owing to the low moisture content of the surface soil. In drought years the same difficulty is encountered in districts that normally have a good rainfall.

The method described aims at producing seedlings with longer root systems than are obtained with ordinary nursery practice. A long root system enables the seedling plant to be independent of moisture in the top six inches of soil, and to draw on sub-soil moisture as soon as it is planted out. The procedure is as follows: — Bamboos with an internal diameter of not less than 2 in. are cut into sections 20 in. long, one end being cut just below a node, which forms the bottom of the receptacle. A hole about ¾ in. diameter is made in the bottom of each section. The bamboos are then split in half longitudinally, and one half of each section is soaked in a 1¼ per cent solution of sulphate of ammonia for several hours.

After soaking the halves are fitted together again and secured with wire of suitable gauge, at top and bottom.

Thus one half of each pot has been treated with sulphate of ammonia, and the other half remains untreated.

Seed should be sown in boxes or nursery beds; when the seedlings are large enough to handle they are transplanted to the pots which have been filled previously with a good potting mixture.

The land where planting is to be done is prepared by digging a large hole for each tree, manuring, and filling in the holes again.

Planting is carried out as follows:—A hole the length of the bamboo pot is made with a crowbar; the wires which hold the pot together are removed, and the halves of the pot are separated. The roots of the plant will be clinging to the half of the pot that has been treated with sulphate of ammonia; this is inserted in the hole with the plant, thus preventing any buckling of the roots, soil is then filled in and firmed down in the ordinary way.

PYRETHRUM BREEDING: A PROGRESS REPORT

By H. C. Thorpe, B.Sc. (Hons.), A.R.C.S., A.I.C.T.A., Plant Breeder, Kenya Colony

In order to obtain the maximum efficiency from a field of pyrethrum it is necessary to plant intrinsically good material. In this connexion, a considerable amount of work is being carried out by the Plant Breeding Services at Njoro on the selection and breeding of high yielding strains of good toxic qualities. Before, however, attempting the synthesis of high test types, it is necessary to determine whether pyrethrin content is a factor that is inherited or whether it is controlled entirely by environment, fluctuating according to, say, rainfall and altitude. If the latter is found to be the case the selection and building up of high content lines will be impossible: breeding work can then do no more than accomplish the production, valuable though this would be, of high yielding strains with desirable agronomic characteristics such as resistance to lodging, production of large flowers, and longevity. The toxicity of such plants would then depend, in a given season, on the environment in which they were growing. But, if toxicity is just as much part and parcel of a plant as is a particular type of flower or a certain habit of growth, then the possibility of isolating or synthesizing high pyrethrin strains falls within the scope of the plant breeder.

Pyrethrin Content

It is already known that pyrethrin content is influenced by many factors under the farmer's direct control, such as regular picking and efficient drying. The toxic content may also be dependent on the altitude at which the plants are grown, although in Kenya this fact has yet to be proved. There also seems to be evidence that the first flush of flowers in the season is highest in pyrethrin and that the content drops as the season advances. But it soon becomes necessary in any breeding programme aimed at improving toxicity, to ascertain how far pyrethrin content is dependent on these factors and how far it is a factor in itself.

In a preliminary investigation into factors affecting pyrethrin content, Gnadinger, Evans and Corl (1933) found a wide range in the yield of flowers and pyrethrins from individual plants, the latter ranging from 0.90 per cent to 2.07 per cent, with an average of 1.27 per cent for all plants studied.

Drain & Shuey (1934) found great variation within and between groups of seedlings of material from Dalmatia, France, Japan, etc., for such characters as height, time of blossoming, tendency to lodge and size of flowers. These observations, and some analyses made by them, suggested the possibility of the isolation of superior commercial strains. A single plant analysing high in pyrethrins was vegetatively propagated and the air-dried blossoms of its progeny showed a high toxic content. The authors emphasize the importance of high pyrethrin content, as well as superior plant characters, in any selections made to improve the crop. Such selections can be propagated vegetatively to reduce to a minimum variation within the strain.

Drain, Gnadinger, Corl and Shuey (1936) have published data to show that high-test strains remain so during three vegetative generations. They also found that within a given strain, pyrethrin content remained quite constant. Their evidence demonstrates the value of high-test pyrethrin strains. If such strains are kept free from mixture with low-test plants, such as volunteers and sports, high-test should continue and remain

high-test although, they point out, environment will play a part in determining pyrethrin content.

The stage at which flowers are picked has been shown by Gnadinger and Corl (1930) to exert a very great influence on their toxicity; open flowers from commercial samples contained 18 per cent to 61 per cent more active principle than closed flowers from the same lots. Since the weight of open flowers is about double that of closed flowers it follows that the pyrethrins produced from a given area of land can be increased three to four times merely by allowing the flowers to mature. Developing fruits were found to contain more than 90 per cent of the active material, the receptacles and and involucral scales accounting for most of the remainder. It is therefore apparent that fertilization of the florets is an important factor.

In a later publication Gnadinger, Evans and Corl (1936) found "a considerable variation in the number and weight of flowers, and a wide variation in the pyrethrin content of flowers produced by individual plants during the same year and from year to year." Progeny lines from high-test mother plants were found to give slightly higher pyrethrin contents than those grown from common seed stock. Evidence was also found of a close relationship between pyrethrin content and temperature during the growing season. Where mean monthly temperature was high, the pyrethrin content was low; in cooler climates the pyrethrin content was higher.

Martin and Tattersfield (1934), on the other hand, state that a given plant yielded flowers containing approximately the same percentage of pyrethrin I for three successive years, whilst the yield of total pyrethrins of flowers from eight individual plants was the same for each plant over successive harvests.

The results so far obtained in Kenya support the idea that pyrethrin content is an inherited character. It seems probable that high-test pyrethrin strains will remain high-test under whatever conditions they are grown, though environment may cause fluctuations in the content of active principle, and the offspring will be mixed, owing to the hybridity of the parents.

Self-incompatibility

If flowers or plants of pyrethrum are enclosed so as to exclude foreign pollen it is found that no seed capable of germination is produced. Even if flowers are artificially pollinated with their own pollen or that from other flowers on the same plant, the result is the same. This failure to form seed on selfing, or self sterility, renders it impossible to "fix" a pure breeding line of pyrethrum and considerably complicates the breeding programme. Pyrethrum is thus a heterogeneous collection of types varying in botanical characters as well as in toxic qualities, and it will remain so on account of continued and enforced cross-pollination.

Out of this miscellany, it should be possible to choose plants having desirable morphological characters yet possessing pyrethrin contents higher than the average. Once such plants are obtained, they will have to be perpetuated by root division since it has been shown that seedlings from high-test open pollinated plants tend to be lower in toxicity on the average than their female parents. Again, such plants can be crossed with others also of high toxic quality and the progeny examined individually for pyrethrin content. It is also possible that plants higher in toxic value than either parent may be numbered in the progeny of the cross. If this transgressive type of segregation occurs in pyrethrum a search will have to be made among the

segregates in the cross for high-content types. This will entail numerous analyses. In fact in all breeding work with pyrethrum chemical analysis is required, since no correlation of any morphological character with toxic content has been found, and analysis is the only means of arriving at a measure of the active principle. Finally, plants of high toxicity but possessing bad characters from the farmer's view-point may be used as parents in the hope of conferring their high pyrethrin content upon progeny from better type plants.

Experimental Work in Progress

I—Selection Work

Breeding studies with pyrethrum were started by the Senior Plant Breeder in 1935 and 1936 by the selection of some fifty single plants from a field of a commercial crop. Selection was based on free-flowering characteristics combined with larger flowers and a desirable habit of growth. Analysis of flowers from splits of these plants showed in 1937 a range of from 1.06 per cent up to 1.80 per cent pyrethrins, the average being 1.36 per cent for the thirty single plants analysed. The remaining twenty selections were discarded on account of poor growth. Since then, further single-plant selections have been made, and the highest figure so far obtained is 2.44 per cent pyrethrins from carefully picked and dried material obtained from the 9,100 feet level. Two other high-content lines picked under the same conditions analysed 2.22 per cent and 2.34 per cent pyrethrins. This highly toxic material is being increased and limited quantities will be available for issue to farmers in 1940.

II—Crossing of High-Test Strains

Crossing was attempted between high-test strains by the isolation of the two parents under muslin cages, but no seed capable of germination was produced. This led to the planting of the two parents together in small plots situated sufficiently far from neighbouring pyrethrum to be deemed safe from foreign pollen. Viable seed was produced and the seedlings resulting from the cross are now being further studied. Those showing promise in possessing larger flowers, better growth and a free flowering habit have been spilt up and are now being analysed for pyrethrin content. By this means it is expected that lines of high toxicity will be built up, possessing also other desirable cultured characters. At Molo, a high altitude station of 9,100 feet, where this work has already been started, promising seedlings of a cross between high-test strains have been selected and split for analyses.

The work on single plant selection is being continued since it is the first step in the building up of high-content lines. It is desirable to have as many high-test lines as possible in order to select amongst them for other characters, and there is still the chance of discovering plants of higher toxicity than those already isolated. A further large batch of plants has been selected and has been planted at Njoro, 7,100 feet, for observation and analysis. There are several new plantations of pyrethrum in the Njoro district, and there will be opportunity, in co-operation with farmers, of visiting these fields and selecting further early free-flowering types of plants. Strains of high toxic value and of a completely free-flowering habit will thus become available for the lower altitudes, where considerable trouble is at present being experienced on account of the occurrence of a varying proportion of late-flowering or non-flowering plants.

Induction of Polyploidy

Polyploidy may be defined as the increase in the number of chromosomes or

heredity-bearing particles within the cells. Such increase is frequently followed by increase in the size of the plant as a whole, as well as of its component parts. Most of the cultivated garden plants are polyploids, derived chiefly by accident rather than design from their common wild and less showy prototypes. The Dahlia is a noteworthy example.

Polyploidy has been and still is a valuable weapon in the hands of the breeder and hybridist, and great advances have in the past been made possible by the use of polyploid parents. The chief interest from a practical point of view lies in the increased size and range of colour and form that is rendered possible and, more especially for the plant breeder, in the production of fully fertile hybrids from sterile species crosses.

Polyploidy cannot be induced at will. It occurs naturally in plant species to an extremely limited extent, but such spasmodic and infrequent natural occurrences are of little use in any breeding programme designed to yield results in the shortest possible time. It is not surprising, therefore, that numerous attempts have been made to bring it under definite control ever since its potentialities in breeding work have been recognized.

Of the numerous artificial methods tried, such as subjection of plants to extremes of temperature, X-rays and other types of radiation, etc. (usually with very indifferent success), perhaps the most promising is the recently discovered treatment with the alkaloid colchicine. Plants vary in their sensitivity to this drug, but from the limited number of experiments so far carried out, it would appear that the method is likely to be of more value than those so far tried.

Chromosome multiplication in fully fertile plants leads, almost invariably, to a decrease in fertility. In plants in which self-sterility is caused by incompatibility factors, as may be the case in pyrethrum, it may be expected, although it would not necessarily follow, that the polyploid plants would also be self-sterile. In garden plants or in others in which propagation may, and usually does, take the form of root division or other vegetative means, self-sterility is of little practical consequence. But in plants in which the development of some active principle is dependent upon full fertility, or in which interest centres in the fruit or seed, maintenance of fertility is of paramount importance.

What then is likely to be the effect of polyploidy in pyrethrum? Here we are concerned not only with an increase in flower size and with other morphological characters, important though these are in the production of commercial strains, but, most important of all, with the content of pyrethrins. The pyrethrins, being formed chiefly in the achenes or fruits depend for their maximum development upon full fertility and efficient seed setting. It is absolutely essential, therefore, to maintain fertility at a maximum so that the greatest content of toxic principles may be obtained. For this reason, the production of polyploid pyrethrum strains, whilst probably leading to an increase in flower size, may also be followed by decreased fertility and a lowered pyrethrin content. On the other hand if, owing to a new chromosome balance, self-fertility is restored the production of high-test strains by inbreeding and selection will be made possible.

It is only by actual experiment that the value of polyploidy in breeding work may be determined. Preliminary tests at Njoro have already demonstrated the possibilities of the colchicine treatment, since great variation is apparent between treated and untreated seedlings.

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A NOTE ON THE WEIGHTS OF FUEL

(Extracted from Bulletin No. 5 of the Forest Department, Kenya)

This bulletin gives the average cubic content in a ton of fuel of varying species. The figures given are for green freshly cut fuel and for air dried fuel. The air dry condition is arrived at generally in two to three months after felling, splitting and stacking.

Indigenous Mixed Hardwoods—Railway Fuel

Average dryness volumes, as weighed at forest stations, varied between 59 to 86 cu. ft. per ton weight.

The figure arrived at by the Railway, after putting twelve trains of fuel from Maguga over the weighbridge, is 66.66 cu. ft. per ton weight.

Selected, Olive and Musharagi

Dry, 55 cu. ft. per ton weight.

Exotics

Grevillea robusta—

Green ... 55.0 cu. ft. per ton weight.
Dry ... 78.0 cu. ft. per ton weight.

Eucalyptus saligna—

Green ... 46.7 cu. ft. per ton weight.
Dry ... 57.1 cu. ft. per ton weight.

Eucalyptus globulus—

Green ... 43.9 cu. ft. per ton weight.
Dry ... 58.4 cu. ft. per ton weight.

Black wattle—

Dry ... 80.0 cu. ft. per ton weight.

In average conditions, green fuel loses about 33 per cent of its weight after three months, from which point the weight remains fairly stationary.

Volumes

E. globulus.—One tree measured at Elburgon. The stacked volume was 115 per cent more than the solid volume.

E. globulus.—52.08 cu. ft. stacked shrank to 51 cu. ft. in three months. 56 cu. ft. stacked shrank to 53 cu. ft. in three months.

E. saligna.—53.15 cu. ft. stacked shrank to 52.1 cu. ft. in three months. 53 cu. ft. stacked shrank to 51 cu. ft. in three months.

The fuel measured was all ordinary axe-cut fuel, not sawn.

REVIEWS

THE ACTION AND USE OF COLCHICINE IN THE PRODUCTION OF POLYPLOID PLANTS, Imperial Bureau of Plant Breeding and Genetics, 1939; 10 pp.; 1/-.

This bulletin summarizes the fairly extensive literature that has been published on the use of the drug colchicine (which occurs in the autumn crocus, *Colchicum autumnale*) to produce changes in the chromosome number in plants. It is the most reliable agent that has been used for the experimental production of polyploid plants, i.e. plants with a multiple of the normal chromosome number, and promises to be of great value to the plant breeder.

An explanation of chromosome doubling is given and then an account of the action of colchicine on cell divisions in the vegetative and reproductive phases. The results obtained from the use of the drug on a wide range of plants are summarized. For the guidance of experimentalists, particular attention has been paid to methods of application and dosage.

Finally the action of another substance, acenaphthene, which has been found by Russian workers to have a similar effect on plants, is described.

This bulletin, read in conjunction with the one reviewed in an earlier number of this Journal (Vol. II, p. 430), "The Experimental Production of Haploids and Polyploids," also issued by the Imperial Bureau of Plant Breeding and Genetics, should be of the greatest interest to all engaged in plant breeding and to those who hope to benefit eventually from the results of the plant breeder's art.

The drug colchicine is already being used in experimental work in East Africa. The Plant Pathology section of the East African Agricultural Research Station, Amani, has bred several inter-specific hybrids of *Manihot* species during their attempts to find or produce forms of cassava resistant to mosaic and other virus diseases. The action of colchicine on this hybrid material is being studied and promises interesting results. An attempt is also being made to induce chromosome doubling in inter-specific hybrids of *Coffea* species by the use of this drug, other methods having failed.

L.R.D.

SOIL-BORNE FUNGI AND THE CONTROL OF ROOT DISEASE, by S. D. Garrett. (Technical Communication No. 38, Imperial Bureau of Soil Science, 1939).

Of recent years it has become virtually impossible for the individual worker, even in a limited field, to familiarize himself with all the results of research on this subject elsewhere, published as many of them are in papers scattered through journals and reports not available outside the larger scientific institutions of Europe and North America. The abstracting journals have done a great deal to make available to the isolated worker, at second-hand and in condensed form, the results obtained in other countries. From time to time it is well to assemble and compare such results in an attempt to correlate knowledge on a particular subject. Mr. Garrett's paper is a commendable example of this summarisation of past and present knowledge.

Most of the work in the field he reviews has been carried out in temperate regions and the comparative dearth of information relating to the tropics should stimulate colonial workers; more

especially as the essential differences between European and tropical practice cause many of the results obtained and usefully applied in temperate regions to be of little practical value in the tropics. The modern views on root disease in rubber in Malaya, and Leach's work on *Armillaria* in Nyasaland, stand out as having been of immediate practical value to the industries concerned through methods entailing little additional expense in crop production.

Garrett points out that the obvious method of control of all plant diseases is to discover or breed crop varieties that are either immune or highly resistant to the more important diseases attacking that crop in general cultivation. For several of the more important tropical crops much progress has been made along these lines during the last thirty years. The outstanding example is sugarcane in relation to its virus diseases. For some crops, however, it has hitherto proved impossible to combine disease resistance with the commercial qualities required in the product, and we then have to rely on whatever control measures can be devised, to minimize loss on the susceptible varieties grown.

In the paper under review, control measures are grouped into those designed to check the dissemination of the pathogens and prevent their introduction into new areas, and methods directed to eliminating them or controlling their incidence after the soil has been infected.

Emphasis is laid on a distinction made by Reinking between the two groups of soil fungi, the *soil inhabitants* and the *soil invaders*. The former include the normal saprophytic soil fungi and a few parasites with wide range of hosts. The latter comprise the majority of the more important root pathogens, more highly specialized in host range and more or less closely associated in distribution with the present or past distribution of their host plants. Most of the second group are unable to compete for long with those of the first group in purely saprophytic existence on non-living soil organic matter, and gradually disappear from the soil flora in the continued absence of their host plants.

Examples are given of various ways in which the fungus parasites are transported from place to place. Dispersal in manures and composts is considered unimportant, as during the fermentations occurring in the manufacture of these the parasitic fungi are killed and decomposed. Their elimination from infected soil is discussed and the methods classified. Direct treatment by fungicides or by heat is of very limited application in the tropics, being confined to such cases as tobacco seed beds. Mechanical methods, comprising digging and rogueing, have long been used on tropical plantations, and the modern methods advised by Napper in Malaya of dealing with root diseases of rubber are probably applicable wherever thick bush or forest is cleared to make plantations of rubber, cocoa, tea, coffee and oil palm. Fortunately in East Africa many plantations have been opened from thin scrub or grassland, and only in limited areas has the problem of root disease been of primary importance.

Crop rotation has long been known as a means of controlling damage from disease, but in many parts of Africa the method is limited by lack of suitable alternative crops capable of being grown at a profit. Leach's work on *Armillaria* is classified as a means of biological control; by rendering the stumps of the original forest unsuited to growth of *Armillaria*, this fungus is replaced by a flora of harmless saprophytes. Control by

adjustment of soil conditions is of limited application in the tropics, as although it is common knowledge that certain soils are more liable to carry diseased crops than others, little can be done to them beyond such purely agricultural treatments as manuring and drainage. The effect of such treatments must be determined for each crop and each disease and often on each area of land affected.

Every worker faced with a root disease problem should peruse this valuable summary. It is more than likely that from the numerous examples of root diseases and control measures included therein he will be able to obtain a close analogy with his own particular problem.

C.G.H.

THE STUDY OF THE SOIL IN THE FIELD (2nd Edition), by G. R. Clarke. Oxford: Clarendon Press, 1938; 192 pp.; 6/-.

The second title of this excellent little book might be "What to look for in relation to a soil"; as a remarkably concise summary of all that affects a soil and of the resultant effects the book will not be surpassed easily. Its keynote is described as the sympathetic study of the "living soil" and of its co-evolution with man. Just as landscape is a living, moving thing to the geomorphologist, so the soil is considered as a living, evolving substance to the pedologist. Under the heading of characteristics of site is compressed into a few pages the whole study of soil environment and development: geologic, topographic, climatic and human influence. The chapter on soil-profile description is a combination of "what to look for" and "how to describe it" and guides the layman through a maze of terms, mostly ordinary words which have acquired a specialized significance. The author has, quite rightly, said little about maps and mapping; he could not have said more without saying a great deal more which has been well-said already.

One is grateful for some mention of tropical soils; new features in the second edition include a Tanganyika *catena* description by G. Milne, a landscape evolution diagram by P. Topham, a vegetation density scale by Burtt, and a description of some of the activities of termites.

Those of us familiar with East African soils may look askance at the change from "Man's Interference" of the first edition to "Man's Influence"; unfortunately, the former is so familiar to us. But the change in heading is well supported by an added two pages of text.

The classification of organic matter has received amplification in this edition, as also have the descriptions of soil texture and structure, particularly the latter. There has been an extension of the section on soil sampling, but even so it remains a counsel of perfection: collection in the dry tropics, where a sample is either a sun-dried brick or a bag of sand, is not dealt with.

The addition of a glossary and an expansion of the index would improve future editions. Thus extended the book would serve as a nomenclature of pedology; as it is, a number of terms, both geological and pedological, are introduced before they are explained.

This book is strongly recommended to all field men, whatever their own particular quest.

D.R.G.

SOME OBNOXIOUS WEEDS OF RESTING LANDS IN UGANDA

By P. Chandler, Plantation Manager, Uganda

In the following notes twelve weeds are considered. Those selected are species that are fairly widespread, but not necessarily universal. The *Oxalis* sp., which was introduced some twenty years ago, is a warning of the danger ahead when plants of such nature are introduced into a country.

Digitaria scalarum Chiov. (gramineae), Luganda name *lumbugu*, is a perennial grass growing up to two feet high (but frequently only about half this height) which reproduces itself by rhizomes rather than seeds. Under favourable conditions the rhizomes are produced rapidly and a network of roots is soon formed, many of which may go two to three feet deep. When this happens the eradication of *lumbugu* becomes both difficult and expensive.

In Uganda this species is common where the soil is fertile and the rainfall well distributed, as in the Buganda Province. It is seldom found where the soil is shallow and climatic conditions are drier, as in the Teso District of the Eastern Province. In Buganda the rhizomes are often so dense and deep that it is a good day's work for a man to dig 25 or 30 square yards. Land such as this usually requires two or three diggings before it is thoroughly clean.

Lumbugu can only be eradicated in one way, namely by deep digging and immediately collecting and burning the plant. Digging is best performed by using the special fork designed for the purpose, procurable locally with either three or four prongs at approximately Sh. 5. The advantage of this fork is that the rhizomes can be withdrawn from the soil with little breaking and can thus be collected more easily. It is important to collect and destroy every piece of rhizome, as almost every bud if not damaged is capable of producing a new plant.

Locally *lumbugu* is a remarkably healthy plant and there are very few records of the species being attacked by fungi.

Oxalis sp. near *O. purpurea* (Oxalidaceae), Luganda name *kajampuni*, is not an indigenous species, but is stated to have been introduced nearly twenty years ago on account of its somewhat decorative appearance. Since then it has spread over large areas, and is particularly troublesome in nursery beds.

It is characterized by its large leaf-segments and conspicuous mauve-purple flowers with yellow throats, which are freely produced on stems slightly longer than those of the leaves.

Reproduction is by numerous small tubers, which vary in size from that of seeds of the larger kinds of millet to that of large castor seeds. It is no doubt due to this variation in size that the plant has attained its present wide distribution. The smallest tubers are easily overlooked during weeding operations, are often reburied, and the plant increases rapidly. Eradication can only be effected by digging out thoroughly and collecting and burning all tubers. As in the case of the previous weed this species of *Oxalis* seems to be remarkably healthy and apparently free from fungus diseases.

Commelina sp. (Commelinaceae), Luganda name *nanda*. A number of species of *Commelina* are to be met with, but the two most common appearing as

plantation weeds are *Commelina africana* L. and *C. nudiflora* L. Both are perennial fleshy herbs with a trailing habit, and produce blue flowers which are of different shades.

Reproduction is by seeds, which germinate freely, or by broken pieces of adult stems, which are capable of producing roots from the nodes. This weed is not difficult to control if dealt with in time, but otherwise a good deal of labour can be involved. Methods of eradication recommended are the rooting up of seedlings in the early stages during suitable weather, and hand collecting of all mature material, either burying it deeply on the spot or carrying it off and burning. It is no use hoeing up mature plants and leaving them to be killed by the sun.

The Commelinaceae are subject to certain fungus diseases. Three are recorded by Hansford in the *East African Agricultural Journal*, January, 1939.

Portulaca quadrifida L. (Portulacaceae), Luganda name *bwanda*, is a herb with small fleshy leaves and yellow flowers and a rather compact trailing habit. Like the species of the previous genus, it is capable of reproducing itself by seeds, or in a similar manner by portions of adult plants, the latter process being the more common. This plant usually appears in places where frequent cultivation is not necessary, or where other vegetation is rather thin. It soon becomes widespread locally if not checked in the early stages. It is to be seen abundantly on earth roads or patches of similar firm soil.

Eradication can be done by burying the collected material.

This weed also appears to be free from diseases.

Portulaca oleracea. L. (Portulacaceae), Luganda name *sezira*, differs considerably in appearance from the previous species as it is much larger and sub-erect, growing to nearly one foot high under favourable conditions. It seems to prefer a habitat where conditions are a little more moist but not retentive of moisture, and it is only under such conditions that it becomes troublesome to any extent. It is similar to *P. quadrifida* in that it is fleshy and produces yellow flowers. Reproduction is chiefly by means of seeds, but mature plants if uprooted and left are capable of re-establishing themselves, and broken portions will produce new plants.

Methods recommended for its eradication are the rooting up of seedlings in the early stages during dry spells, hand collecting of mature plants and burning or burying them deeply.

It is a weed with some minor food value among certain tribes, who use the leaves as a vegetable. Like the species above, it appears to be disease-resistant.

Euphorbia heterophylla. L. (Euphorbiaceae), Luganda name, *kasandasanda akanene*, is an erect annual herb growing to a height of three feet under very favourable conditions, but more often to six to eighteen inches. It has small pink flowers, but rather large fruits and leaves. Reproduction is by seeds, which germinate freely and rapidly under ordinary cultivation conditions. The seeds appear capable of remaining dormant for a period and of retaining their viability when subject to coarse grass or bush conditions.

Like several other weeds, it only becomes a nuisance if not checked in the early stages. It produces a carpet-like mass of seedlings in a very short time. The plants can be disposed of easily in dry weather, but mature plants if uprooted and left on the surface are capable of re-establishing themselves during showery spells. To get rid of these, burying or collecting and carrying off is necessary.

This *Euphorbia* is susceptible to at least one fungus disease, which attacks the leaves and is seen as bright orange spots which are at times so thick that they merge into one another.

Euphorbia hirta. L. (Euphorbiaceae), Luganda name *akasandasanda akawanvu,* is a sub-erect annual herb growing to nearly a foot high, but often very much less and as little as two or three inches only when stunted. It is easily distinguished by its general colour, which is pinkish brown or sometimes purple in very stunted plants, or dark green with patches of purplish pigment when conditions are more luxuriant; very frequently the stems are of a pink shade. Later on both the buds and the numerous small flowers show purple colouring. Reproduction is chiefly by seeds.

This weed is not usually troublesome in plots undergoing cultivation by ordinary methods. It is often troublesome, however, in lawns, or on plots allocated to dwarf growing grasses such as *Cynodon dactylon,* the more so if these have been laid down for some time and are beginning to show signs of exhaustion. It is usually worse during the dry season and can then be quite dominant for a time.

Eradication is recommended to be by hand weeding if on a very small scale, or by complete replanting of the whole area if on a large scale.

Euphorbia prostrata Ait. (Euphorbiaceae), Luganda name *kasandasanda,* is of prostrate habit, though individual plants often appear less so on account of being compact and occupying a small space. It is easily identified by its habit and its glaucous purple appearance, which is due to the many small grey-green leaves and the large number of very small pink-purplish flowers open at one time. Reproduction is by seeds, which are small in size; as in the previous species, it is quite common to find extremely small plants seeding freely. The habitat of the plant includes roads and paths and patches of firm soil. During dry weather, however, it can be quite troublesome in lawns that are showing signs of exhaustion. Eradication methods should follow those as recommended for *E. hirta* above.

Bidens pilosa. L. (Compositae), Luganda name *sere,* is too universal and well known by its seeds, commonly referred to as "Blackjacks," to need much describing. In Uganda its distribution is very widespread. It is an annual which varies in height from a few inches in unfavourable conditions to almost shoulder-high where conditions are very favourable. In either case it is capable of producing seeds freely, which germinate in carpet-like formation, an effect which is particularly noticeable on land that is resting after carrying a spring crop, or alternatively near the edges of recently-opened-up forest land. In spite of the multitudes of seedlings, control is easy if performed at the right stage and during dry weather, as the young plants then succumb easily.

This plant is less resistant to fungi than several of those mentioned previously; three diseases are recorded by Hansford, 1937.

Galinsoga parviflora Cav. (Compositae), Luganda name *kafumbe,* often known in East Africa as *MacDonaldi,* is an annual weed which has become naturalized in Uganda as in several other parts of the world. It is a native of Peru. Where common, it is conspicuous by growing in mass formation like *Bidens pilosa* and producing numerous small flowers with white petals around large yellow centres. The foliage is light yellowish green and the plants attain a

height of nearly two feet under favourable conditions. Frequently, however, they are more often between nine and eighteen inches high.

Reproduction is by seeds which are produced abundantly and germinate both freely and rapidly. The plant need not become a pest if the seedlings are rooted up when only two or three inches high.

Cissus sp. (Ampelidaceae), Luganda name *kabombo*. Two, perhaps three species are found in Uganda which, if allowed to survive, are harmful to growing crops. Collectively their numbers are less than any of the weeds mentioned previously. They are perennials with long, fleshy, and rather fibrous tubers which are buried deep in the soil, and their tendrilled stems frequently climb to a height of several feet. These weeds are troublesome at times by their smothering effect on crops. The tubers go deep down, and unless treated with care when weeding is done they are chopped off and left in the soil. The only way to deal with them is to dig them out completely.

Mariscus sp. (Cyperaceae), Luganda name *nku*. There are several Uganda weeds that are members of this genus or family; locally most of them inhabit moist or wet places. It is common to find *nku* growing in lawns that are exhausted or are subject to very dry periods, or it can be equally common in areas of after-cultivation in the vicinity of swamps.

This particular species of *Mariscus* is easily distinguished by its whitish flowering heads (those of most species of *Mariscus* are green) and by its dwarf habit. It does not often grow to a height of more than six inches, usually it is much less. This depends greatly upon habitat and upon whether the plants are subject to being chopped off at intervals.

Reproduction is mainly by rhizomes, which are produced from somewhat swollen rootstocks not far below the surface of the soil. The rhizomes do not penetrate deeply like those of *lumbugu* (*Digitaria scalarum*), but are often just deep enough to remain in the soil after the upper part of the plant has been cut off during weeding operations. Thus they still survive, produce new plants and continue to multiply.

The only way to eradicate this weed is to uproot the rhizomes completely, collect them soon after, and dispose of them by burning.

NATIVE METHODS OF FOOD STORAGE IN NYASALAND

By E. Lawrence, C.D.A., N.D.A., Agricultural Officer, Nyasaland

This is a very brief description of the different methods of storing foodstuffs in Nyasaland. Some sort of receptacle is usually made, but seldom is there any attempt to give protection against attack by insects, rats and mice, and the annual loss from this cause is extremely heavy. Even monkeys and baboons take their toll of stored grain, and I have several times seen them actually robbing stores, particularly when situated on the edge of a village.

As the receptacles are generally by no means airtight, and the stored grains or pulses usually quite ripe and dry, little loss is suffered from moulds or rots.

The names and brief descriptions of the commonest types of stores are given below:—

The Nkokwe (Fig. 1) is the largest and commonest kind of grain store in Nyasaland, and every family owns two or three or more. It is cylindrical in shape and usually made of interwoven split bamboos with a detachable conical-shaped roof of thatched grass; the sides are sometimes plastered with a thin layer of mud. Reeds, small branches, poles of *balisa* (*Pterocarpus* sp.), cedar, or tall *tsekera* grass (*Hyparrhenia* sp.) may be used instead of bamboos. The *nkokwe* sometimes stands on the ground, but it is more often built on a platform, and occasionally two or three are placed on the same platform. The size varies, but the usual height is about 6 ft., and the diameter between 4 ft. and 5 ft. When filling or emptying, the grass roof is removed.

The *nkokwe* is used for the storage of most unthreshed grain and pulse crops, and the word *nkokwe* not only applies to this particular form of grain store but to any form of grain store unless given a particular name.

The *Chete* or *Chindande* (Fig. 2) is a pole and grass hut built on a platform. The size varies considerably, but the height of the walls is usually about 4 ft., the floor standing between 3 ft. and 6 ft. off the ground.

Like the *nkokwe,* this is also used for storing maize in the cob and unthreshed grain, chiefly bulrush millet, rice and sorghum. Late in the year it may be used for the storage of sweet potatoes.

The *Gwangwa* is a smaller type of *nkokwe,* similarly made of bamboos, reeds or small sticks, but unlike the *nkokwe,* it is always mudded, inside and out. It is used for the storage of groundnuts, finger millet, Bambarra groundnuts and beans. It stands 3 ft. high on a small platform, and is between 2 ft. and 3 ft. in diameter.

The *Chimbuli* is a small portable grain store made of interwoven bamboos, mudded in side and out, and shaped like a bottle with a narrow tapering neck. Its height and the diameter at its base are usually about 2 ft.

Small grains and beans, which are particularly susceptible to insect attack, and sometimes small dry cassava cubes (*makaka*) are put inside. When filled, the top is sealed with mud.

The *Chikwa* (Fig. 3) is a conical-shaped basket made of woven grass and palm leaf, standing about 4 ft. high, with a diameter of 3 ft. to 4 ft. at the widest part. The builder sits inside while working until the "neck" is reached, when of course he has to finish from the outside.

FIG. 1—*Nkokwe*

FIG. 2—*Chete*

This type is very common on the Lower River in the south of Nyasaland, and is peculiar to this area. It is filled with threshed or shelled grain and pulses, and is kept just outside the living hut, often tied to the roof.

The *Tata* is a *chikwa* on a platform. Fire is kept underneath, the smoke travelling up through the stored grain. This type, like the *chikwa,* is seldom seen away from the Lower River.

FIG. 3—*Chikwa*

The *Sanja* (Chinyanga) or *Ligulu* (Chiyao) is simply a platform on which the grain is spread out. A small smoky fire is kept burning underneath, the smoke keeping away weevils. Maize in the cob, mapira[1] in head and unthreshed grain are treated on the *sanja.* An *mbiya* (mud cooking pot) is used for storing small quantities of grain that are being kept for seed. Mawere,[2] beans, pumpkin seeds and rice are often stored in an *mbiya.* The mouth of the pot is sealed with mud, and every now and again the owner removes the seal, empties out the seed, suns it, returns it and re-seals the pot.

FIG. 4
Bundles of seed in grass and palm leaves.

A quite common method of storage is that of hanging up small bundles of heads, generally selected for seed, in the roof of the hut, where they are always in a smoky atmosphere. Often the heads are hung up

1 ? Kaffir Corn (*Sorghum vulgare*).

2 ? Finger Millet (*Eleusine coracana*).

The attention of contributors is called to p. 164 in the November number of the current volume of this Journal.—*Ed.*

in a tree outside, but when this is done they are usually wrapped up in dry grass or palm leaves, making long cigar-shaped bundles (Fig. 4). Small quantities of threshed grain may be stored in bags made of bark or goat-skin, and these too are usually suspended from the roof of the hut, where the smoky smelly atmosphere apparently discourages grain weevil and moth.

It will be seen that most grains and pulses are stored unthreshed, in head, cob or pod, and that when threshed grains or pulses are stored very much more care and attention is paid to them. The smaller grain stores, such as the *gwangwa, chimbuli, chikwa* and *mbiya,* are more carefully made and are kept in or near the house and given fairly constant attention. As a rule, of course, they contain seed for the following season, and for that reason alone are very valuable.

With the exception of sweet potato storage, very little use is made of wood ash, although its value as a deterrent to insect attack is known. It is occasionally mixed with grains and pulses stored as seed in the smaller stores, but never in the large *nkokwes* and *chetes.*

Sweet potatoes are often stored in pits, mixed with wood ash, but the loss from white ants and mould is very great. They are also stored in the *chete.* Cassava is usually stored in the *chete* in the form of small cubes, known as *makaka.* The roots after lifting are cleaned, peeled, cut up into small cubes and dried on the roof of the owner's hut. The *chimbuli* is occasionally used instead of the *chete.*

Flour and meal are never stored. In the preparation of meal, the grain is washed, and although dried afterwards the resulting flour becomes sour after about twenty-four hours.

MANILA HEMP SEEDLINGS

It is recorded in the literature on the subject that Manila Hemp rarely produces fertile seeds. With a view to testing this belief some thousands of freshly gathered seeds of *Musa textilis* (derived from a clone introduced from Java in 1904) were sown in nursery beds at Amani last October and carefully tended. No less than 65 per cent of these seeds germinated after two months. This ability to raise seedlings of Manila Hemp, apart from other possibilities, may show the way to the production of new and better varieties suited to East Africa, should these be needed, and possibly obviate the necessity for introducing varieties from abroad with the attendant risk of introducing diseases now unknown here. Because of this risk the importation of Musa varieties from abroad is prohibited in East Africa, except with the concurrence of the directors of agriculture, as the danger of introducing virus and wilt diseases that have devastated banana growing industries in several countries is particularly to be feared in parts of these territories where the local population depend largely on the banana for their staple diet.

Some of our readers may be interested in the published reports on the fibre qualities of certain indigenous Musa species which appeared in the Bulletins of the Imperial Institute for 1905 and 1938. These indigenous species, it was shown, yield fibres comparable to those obtained from Manila Hemp, but it appears that their low yield and the difficulty of extracting their fibre may hinder their commercial development.

A.G.H.

SOME SOUTH AFRICAN INVESTIGATIONS ON FODDER CROPS, FIELD CROPS AND ANIMAL HUSBANDRY*

By R. S. Ball, M.A., Dip. Agric. (Cantab.), A.I.C.T.A., Agricultural Officer, Kenya Colony

Forage and Fodder Crops

At the School of Agriculture, Potchefstroom, trials are now being carried out of forage and fodder crops and methods of converting these crops into silage, though this latter work had not reached any advanced stage at the time of my visit and little information was available. The most outstanding forage crops were the erect strain of cowpea bred by Dr. Saunders (which would be worth trial in the drier parts of Kenya, as at Rongai), Soya beans, and certain types of silage maize bred for the purpose. Considerable importance is attached to Kaffir corn and sorghums as forage and grazing crops, and various strains of these are being selected for characters such as stooling capacity and drought resistance. In addition, experiments are being carried out on the losses entailed in the processes of ensiling and haymaking. It is found that the losses in haymaking may amount to 40 per cent of the total bulk. As in Kenya, the purchase of concentrated foods for dairy animals is avoided as far as possible, and attempts are being made to solve feeding problems by the use of silage mixtures of high protein content, hays, and home-grown starchy foods. It has been found that cowpeas have a protein content 3–4 per cent higher than that of lucerne. It is interesting to note that lucerne is rarely a profitable crop in the area unless irrigation is possible.

Three varieties of spineless cactus are cultivated for forage, of which the variety *fusicaulis* has proved the most suitable. It is possible that this variety would be worth trial in Kenya if not already in the Colony.

Maize

Work on maize breeding, on lines similar to those in Kenya, is being carried out at Potchefstroom. The most interesting feature is the breeding of synthetic varieties from the pure lines that have been established. It is interesting to note that neither in these synthetic nor in double crossed strains are great increases in yield expected over varieties at present being grown by farmers, but it has been found that characters such as drought resistance can be established in the strains, so that in a dry year, heavier yields will be obtained from these strains than from the farmer's own seed. On the other hand, in a wet year such as that at present being experienced, no increases in yield over the ordinary varieties are experienced. In most years, however, this character of drought resistance is of paramount importance.

These synthetic varieties are produced from about 14–16 selfed lines which are first crossed and then double crossed as completely as possible.

The seed from these resulting double crosses is then mixed together and sown in an isolation plot for multiplication, after which mass selection is practised.

It is considered that the labour involved in producing annually double crosses for issue on a large scale is too great to warrant such work, and for this reason efforts are being concentrated on the production of synthetic varieties.

* *This is the concluding article, based on information obtained during a visit to South Africa in February,* 1939. *The previous article appeared, in two parts in the September and November numbers of this Journal. It dealt with South African grassland investigations.*

Manurial experiments at this station include the application of phosphatic and nitrogenous fertilizers to maize at different stages of growth. In addition, trials of green manures such as sunn hemp and cowpeas are being carried out. The response to superphosphates is very marked and also to rock phosphates over a period of years. There is a slight depressing effect on the yield of maize after cowpeas in the first year, but in the subsequent year, yields generally show an increase over the control plots. It is interesting to note that superphosphate can be broadcast on the land some time before planting, which is in marked contrast to Kenya, where it is generally necessary to drill such fertilizers with the seed. One of the most striking results of the effect of phosphatic manures was an appreciable shortening of the period required for maturity by the maize crop.

Animal Husbandry

Work is being carried out on the production of fat lambs, at the School of Agriculture, Potchefstroom, but experience is generally that the cost is likely to be too high in an area where it is only possible to sell a very small percentage of fat ewes. The Persian sheep is used as a basis, being crossed with a ram of mutton breed, such as the Suffolk, Southdown or Shropshire. The first-cross ewes are then again served with a ram of mutton breed, preferably the Ryeland or Dorset Horn, which have proved the most suitable; and all the progeny are sold as fat lambs. This practice is suited to dry areas where the Persian sheep is likely to flourish, but the poor mutton qualities and absence of wool of this breed are factors against success.

The results of line-breeding Merinos for the evolution of a type without wrinkle are also to be seen.

There is no experimental work on poultry at Potchefstroom at present, but an exceptionally well run unit is in existence. Various types of both portable and permanent houses are used, several of which could be suitably modified for Kenya conditions, in particular the movable outdoor ark and the colony laying houses.

The methods of egg recording and trap nesting were also investigated and a considerable amount of useful information was obtained.

At Cedara a well-run poultry unit affords opportunity to study the methods of conducting laying trials. Individual pens are used in preference to trap-nesting.

It is interesting to note that the maize and skim milk feeding of poultry which was recommended at one time from Cedara, but which has been discouraged in Kenya, has proved to be a failure. The birds drew too heavily on the reserves of protein in their bodies with the result that after the pullet year, egg yields fell to very low levels. Attempts to rear chickens on this diet have been accompanied by high mortality and poor growth.

One interesting experiment has shown that lime having a high magnesium content is dangerous to poultry when fed in the mineral ration, since it is likely to cause serious kidney trouble. It is possible that this may be the cause of the many unexplained losses experienced of recent years on some farms in Kenya where mineral rations were liberally fed, and it would be well for the lime fed in Kenya to be analysed for the purpose of determining its magnesium content.

Experiments are being carried out at Potchefstroom on the breeding of a suitable type of beef animal for large-scale ranching conditions, under which high grades of the English breeds may

lose weight very rapidly during the winter. The progeny of Afrikander female stock by cross-bred Afrikander-Angus bulls or other English breed are likely to be suitable, all such progeny being sold for slaughter.

It has been shown that the winter feeding of bullocks with rations of high protein content is not economical since the growth rate during the spring months, during the first flush of grass of high protein content, is higher in the animals fed on the lower protein ration during the winter. The result is that although the animals fed on the higher protein rations in the winter increased in weight more rapidly during the winter months, yet the total annual increase was only very slightly different between the two groups. The results of this work are probably of some application to Kenya dry-season conditions and indicate that heavy protein feeding is not likely to be economic.

At Cedara, lower-yielding Friesian cows from the dairy herd are served with an Aberdeen Angus bull and all the resulting progeny sold. Use is made of these store animals for clearing up in the paddocks after the dairy herd, and it has been demonstrated that such animals can be fattened without additional feeding on this improved pasture. All dairy heifers are served for the first time with a dairy bull, and if their milk records are not satisfactory, they are subsequently served only by a bull of beef breed.

The work of breeding for high butterfat yields depends on the fact that the butterfat character is a homozygous recessive and line-bred bulls are being used. It is found, however, that there is a tendency to perpetuate faults such as narrow muzzles in this line breeding, although the stock generally do not show signs of general loss of constitution. The work has not yet proceeded very far and the results to date are indefinite, although there has been a slight upward tendency in butterfat percentages amongst the most recent progeny.

CHANGES IN COMPOSITION OF HYDRATED LIME STORED IN NON-AIRTIGHT CONTAINERS

By G. H. Gethin Jones, M.Sc., Soil Chemist, Department of Agriculture, Kenya Colony

It is known that hydrated lime decreases in total alkalinity, due to the formation of calcium carbonate, when stored in containers that do not seal the contents against atmospheric influences. In this investigation large uniform samples, weighing about 74 lb., of very finely ground hydrated lime were put aside in jute and sisal bags respectively, for the purpose of measuring the rate and the extent of this change. At the same time, the relative merits of jute and sisal bags might possibly be compared. A small sample of the same original material, contained in a sealed bottle, was kept for control purposes. Two methods of sampling the bags were employed: in one a composite sample of the whole was taken, and the other represented the outer inch round the sides of the bags only. The degree of chemical changes brought about respectively by protection from and exposure to atmospheric influences could therefore be measured.

This hydrated lime, when originally sampled by the makers, was reported to contain 96.1 per cent of hydrated lime and 2.7 per cent of carbonate of lime, the remaining non-calcium compounds being 1.2 per cent only. However, on sampling at these laboratories on 14th August, 1939 (fifteen days after despatch), all samples, including that in the sealed bottle, contained very much more carbonate material. It is not known whether the material submitted had been exposed before bottling. As the material in the bags loses its uniform composition, due to a greater degree of change to carbonate in the outermost parts of the bags, there must be an appreciable sampling error, but this would tend to even out in the series of samplings from the two bags. The following analytical data, showing the degree of carbonation with time for the two types of samplings, illustrate the changes that occur:—

Date of Sampling Material	Calcium Carbonate (Composite)	Calcium Hydrate (Composite)	Calcium Carbonate (Outer inch only)	Calcium Hydrate (Outer inch only)
	Per cent	*Per cent*	*Per cent*	*Per cent*
Original Sampling ..	2·7	96·1	—	—
14–8–39 After 15 days				
Bottle	14·2	80·8	—	—
Jute bag	16·6	78·4	18·2	77·0
Sisal bag	17·0	77·8	18·5	76·5
Bag average ..	16·8	78·1	18·35	76·75
13–9–39 After 45 days				
Jute bag	20·8	77·7	27·1	70·6
Sisal bag	21·0	75·5	26·9	69·4
Bag average ..	20·9	76·1	27·0	70·0
18–10–39 After 80 days				
Bottle	14·4	80·2	—	—
Jute bag	21·0	76·6	29·6	68·2
Sisal bag	21·3	76·4	30·0	67·6
Bag average ..	21·15	76·5	29·8	67·9

Discussion

The comparative figures for the jute and sisal bags show that there is no significant difference in the merits of these two non-airtight containers for storing hydrated lime. The two sets of figures can, in fact, be used to serve as duplicates in following the changes that occur during such storage of hydrated lime. The first analyses of the two composite samples at the laboratories showed an average of 16.8 per cent of calcium carbonate, which was only slightly less than the 18.35 per cent of carbonate in the outermost inch of the bags. This fact, coupled with the finding that 14.2 per cent of calcium carbonate was contained in the bottled sample, suggests that the

hydrated lime contained about this latter amount of carbonate when bagged. This unfortunately lowers the value of these tests since it does not show the changes that obtain on the similar storing of a more pure sample of hydrated lime. It only shows the changes from this stage onwards.

A study of the trend of the figures and drawn graphs, representing the increased formation of calcium carbonate beyond the 14.2 per cent against the number of days, shows that the "outer inch" layer rapidly forms calcium carbonate at the start and then the change gradually lessens until it becomes very slow after about ten weeks, when the amount of calcium carbonate present is about 30 per cent. It is likely that the amount of carbonate increases towards the outermost layers, so that the exposed extreme outside contains no unaltered calcium hydrate; depths of sampling successively shallower than one inch would probably have shown increasingly larger amounts of calcium carbonate. This outer layer of altered material, as it is formed, seems to seal the inner contents of the bags against rapid conversion to calcium carbonate.

The average of the whole bag, including the outer inch layer which comprises about a quarter of the contents of bags of the size used, increases from about 14 per cent to 20 per cent in four weeks and then shows only a very small further change. This average change is almost entirely accounted for by the greater change from 14 per cent to 30 per cent in the outer inch only, thus the inner contents of the bags were only slightly altered.

This work suggests that single bags of hydrated lime of this original composition and size, standing exposed to the atmosphere on the estate, may deteriorate until about a third of their average contents is converted into inactive calcium carbonate in about three months. On the other hand, it is likely that stacks of normal-sized bags would be subjected to relatively less change as the superficial exposed area would be correspondingly less with a greater mass of closely packed bags. The protection against the conversion of the interior portion is dependent on the efficiency of the outermost carbonated layers, once these are formed, in excluding the movement of air and its contained carbon dioxide into the general mass.

On arrival, the sisal bag weighed 74 lb. and the jute bag 74½ lb. The former container had a greater amount of material held loosely within the mesh of the twine which fell to the ground when the bag was gently handled. The final weight of both bags, after 65 days in the store, was about 78½ lb., or say 79 lb. each after allowing for the amounts removed and lost during sampling. Thus the deterioration in the quality of hydrated lime is accompanied by a corresponding increase in the weight of the bags.

Hydrated lime should, if possible, be purchased in sealed drums on a guarantee of analysis. Failing this, special efforts should be made to obtain supplies of freshly made material only, to meet immediate requirements. Any surplus stocks, if not kept in airtight containers, should be packed close together and entirely covered with sacking or old tarpaulins so as to minimize the free movement of air which causes carbonation and hence a reduction in the alkalinity and the value of the material. These comments are equally applicable to unhydrated lump lime or quicklime.

An examination of the bags, which had contained non-caustic hydrated lime for a period of three months, showed that both sisaltex and jute bags had not deteriorated. All seams were intact, and neither fabric showed signs of rotting.

NOTES ON FOOD STORAGE

By W. Victor Harris, Entomologist, Department of Agriculture, Tanganyika Territory

The following foodstuffs are more or less immune from insect attack during storage and, provided that they are kept free from rats, should last a number of years without serious loss:—

Bulrush millet (*Uwele*),
Eleusine (*Ulesi*),
Green Gram (*Chiroko*),
Pigeon Pea (*Mbaazi*),
Groundnuts (*Karanga*),
Sesame (*Ufuta*).

The more important groups of insects attacking stored foods are:—

Grain Weevils.—Small black and brown weevils attacking wheat, sorghum, maize, rice.

Pulse Beetles.—Small square brown or spotted insects attacking most pulses, and particularly cowpeas (*kunde*).

Flour Moths.—Various species of small dull moths, whose caterpillars infest starchy foods—wheat and maize flour, cornflour, and grains which have been broken during threshing, particularly rice, together with such products as dried fruits, chocolate, etc.

Fumigation

The only satisfactory way of ridding foodstuffs of insect pests, once infestation has become established, is by fumigation. Fumigation should under no circumstances be left to natives or unskilled operators.

Carbon bisulphide is usually used, the dosage being 5 lb. per 1,000 cubic feet of air space or, if the container is full of grain, 1 lb. per 25 bushels. (*Note.*—One bushel of rice = 50 lb., maize = 60 lb., pigeon pea = 56 lb.) If the container is not reasonably airtight, the dose must be doubled or even trebled. The length of time required is twenty-four hours at temperatures of 70° F. or over. The carbon bisulphide is placed on top of the grain, as the fumes *descend.* Care should be taken not to bring flames or sparks near any air liable to contain carbon bisulphide vapour, as such a mixture is highly explosive.

Hydrocyanic acid gas, generated by the action of sulphuric acid on potassium or sodium cyanide, is also a fumigant. It is more suited to the disinfection of buildings such as flour mills, as there is no danger of explosion. Penetration varies between "slow" and "nil", owing to surface absorption, and for this reason it is doubtful whether hydrocyanic acid gas is suitable for fumigation of foodstuffs without prior experiment in each case. It is extremely poisonous. It is used at the rate of 10 oz. potassium cyanide (or sodium cyanide), 10 oz. sulphuric acid (commercial concentration), 30 oz. (1½ pints) water, per 1,000 cubic feet of space; time, 20 to 24 hours. The sulphuric acid is first of all added slowly to the water in a suitably large vessel. The cyanide is best lowered in a paper or cloth bag by means of a string controlled by the operator at a distance.

In fumigation all preparations such as sealing holes with mud, etc., should be completed before the fumigant is introduced. Door cracks and window-frames are rendered reasonably gas-tight by means of brown paper and plenty of glue.

In all cases open up the building and give the gas at least half an hour to escape before entering.

Increase of dosage will reduce the time of exposure, and vice versa.

Storage

Stores should be clean before foodstuffs are brought in, particularly if they have been used for the purpose previously. Infection from dirty stores is the commonest and most serious danger to all foods. Unless fumigation is to be carried out in the buildings, and this is rarely practicable, the store should be well swept out and then the walls sprayed with paraffin containing ½ lb. of powdered pyrethrum per gallon (and kept for at least twenty-four hours before use) in order to kill insects hiding in cracks and crevices. Ordinary mosquito gauze will keep out pulse beetles and flour moths, but not grain weevils.

Powdered calcium carbonate (ground limestone) or fine slaked lime, mixed with grains in the proportion of 1 part to 50 or 100 parts of grain, will materially assist in keeping down grain weevil injury for eight months or so. *It is useless against pulse beetles.*

Where grains and pulses are stored in bins or containers the sides of which are insect-proof (i.e. of metal, cement, brick or uncracked earth and cow dung over reeds), the incidence of both grain weevil and pulse beetle attack can be minimized by keeping a layer of from two to three inches of clean sand over the top of the container instead of a lid or cover. Newly emerged weevils and pulse beetles instinctively move to the top of the grain on emergence from the grub stage, and on penetrating through the layer of sand do not descend again. This method is thus of value even if the produce is mildly infested before storage. The containers require to be inspected at intervals to ensure that the layer of sand is intact. This method is suitable for native stores of the *ngokwe* type and for large open bins, particularly if the product is drawn off from below.

In all cases, but particularly when other methods are not possible, full use should be made of the sun's heat. Not only should all grains and pulses be bone dry before storing, but a good sunning will drive out insects, particularly if accompanied by winnowing, and can be repeated to good advantage at intervals of from three to four months.

Some system of grading stores is recommended so that clean or freshly fumigated grain is not brought into a store containing old and possibly infested material, *fumigation being no preventive of reinfection.* A series of well-built native *ngokwes* may, in such cases, be preferable to a single open iron godown.

Sulphur dioxide, made by burning sulphur, is used as a fumigant for buildings to destroy rats and cockroaches. It is not very suitable for use when grains, flour and foodstuffs generally are present, owing to slow penetration and chemical action, but is a useful preliminary to storage, providing the room can be made fairly gas-tight. About 3 lb. of sulphur are burnt per 1,000 cubic feet of space.

Readers are reminded that an article on the storage of foodstuffs appeared in the issue of this Journal for March, 1937, *p.* 349; *it was compiled by the Imperial Institute, London, and dealt not only with grains and pulses, but also with yams, cassava, and sweet potatoes.*—ED.

STUMP PLANTING

By N. V. Brasnett, Conservator of Forests, Uganda

Propagation of trees by root and stem cuttings, commonly known as stump planting, is now normal practice over most of the tropics. It depends on the fact that both root and shoot systems of a number of species can be regenerated from a length cut from the main axis of a seedling to include a portion of stem and taproot. Leafy shoots spring up from the stem some time before root growth starts. This latter usually takes the form of one or more sinker roots from the cut end or a little above it and of horizontal feeding roots from the same parts and higher up the root stock. Some species which are not well suited to this form of regeneration may produce healthy looking shoots which afterwards die because no roots are formed.

The method originated in India where it was first used to stock new areas of irrigated plantations in the Punjab plains with sissu (*Dalbergia sisoo*). Its success and cheapness led to its adoption for teak (*Tectona grandis*) planting and even more rapid establishment of teak plantations was obtained than of sissu.

The latest information from India[1] is that, besides teak and sissu, many of the commonly planted species such as rosewood (*Dalbergia latifolia*), tun (*Cedrala toona*), *Gmelina, Albizzia,* etc., grow well from stumps. Notable exceptions are sal (*Shorea robusta*), Hopea (also a Dipterocarp) in most localities, Magnoliaceae and many Anacardiaceae.

Nigeria reports[2] "This (stump planting) is the most infallible method of establishing plantations . . . . Most species will grow from stump plants."

In Uganda, *muvule* (*Chlorophora excelsa*), all the mahoganies (*Khaya and Entandrophragma*), *musisi* (*Maesopsis eminii*), *Afzelia, Daniellia,* etc., can be established from stumps, as also can several of the more commonly used exotics, e.g. *Cassia siamea* and *neem* (*Azadirachta indica*). A very good Eucalypt plantation was once raised from stumps, but a subsequent attempt failed, and as gums are so easily planted out by the open root method from trays, no further experiments were made.

Considerable research has been carried out in India to ascertain the best size (length and thickness) for root and shoot cuttings. This has recently been summarized by Champion.[1]

"Stump planting depends on raising rather large nursery stock, usually not lined out, and pruning it down before planting to sticks usually about 10 in. to 11 in. long consisting of 9 in. of root and 1 in. to 2 in. of stem. A clean straight tap root is required. All side shoots are pruned off, though it is usually best to reject all plants with branched roots. A thickness between that of the little finger and a pencil is usually best, though the optimum dimensions undoubtedly vary with the species. A short stem length appears to reduce the tendency to produce several equal shoots (sissu), but possibly is unsatisfactory with some species such as mahogany. A shorter root length may be used in climates with favourable moisture conditions, thus a 6 in. root has often been used for teak, though 9 in. is necessary in drier localities."

1 Champion, H. G., and Trevor, G.: *Manual of Indian Silviculture*; Oxford University Press, 1938.

2 MacGregor, W. D.: *Silviculture of Mixed Deciduous Forests of Nigeria*; Oxford Forestry Memoir No. 18, 1934.

Experiments in Uganda have been more rough and ready, but they have demonstrated that stumps of large diameter produce fewer failures and more rapid growth than smaller ones. A root length of 9 in. to 10 in. and as short a stem as possible seem best for most species, including mahogany, but stems of 9 in. to 12 in. have been used with greater success than short ones in the case of *Cassia siamea* on soils liable to be waterlogged. The upper limit for diameter has not been found and stumps 3 in. to 4 in. across have done the best in difficult situations. However, the question of cost arises and the problem is to determine to what extent establishment and tending costs, particularly in the case of line and group planting in existing forest, can be reduced by the use of the more expensive large stumps. What is required is nursery stock which will grow at least six feet in the first year and so obviate the need for further protection against browsing and low weeds. Some large *muvule* stumps cut from three year old nursery plants will do this (8 ft. 2½ in. growth in 12 months was recorded from one in 1937-38), but it does not seem that a general average of 6 ft. can be relied on. Experiments are now being carried out with partial root and shoot pruning (undercutting and slight lifting in the nursery beds) such as is practised with oak in Europe. Indications are that *muvule* and mahogany plants with 6 ft. of stem may save much more than their initial nursery and planting costs by requiring less tending and protection. Whether this proves to be so or not there will still be many areas and many species for which cheap stump planting will remain the best method.

At one time fears were expressed that the use of stumps would result in considerable stem and root rot, but the evidence to date shows that this has not been the case.[1] The rapidity with which a new shoot grows over the cut stem surface, particularly of a low stump, is undoubtedly a factor in preventing rot.

Stumps can be stored, can be transported long distances without damage, and are cheap to plant, both because of their portability and the absence of small roots requiring skilled handling. The disadvantage that part of the short tropical growing season is lost before the original leaf surface removed in the nursery has been restored can also be an advantage in localities in uncertain rainfall, because stumps will suffer much less from a dry spell after planting than entire plants do. In India stumps are planted earlier than entire plants and pre-monsoon planting is standard practice in many localities.

One valuable use of stumps is for filling blanks in plantations quickly. *Cassia siamea* can be established from seed when rains are favourable, but in Uganda we always take the precaution of sowing a part of the area thickly to produce stumps for later planting in all gaps. These stumps are able to catch up with the original crop more quickly than seedlings could. In areas where climatic conditions are unfavourable it is safest to use Cassia stumps from a nursery at the beginning and to avoid the waste of seed caused by repeated sowings and deaths from drought.

TUNG OIL

The following note on the subject of tung oil trees has been received from Mr. J. F. Perkins, of Teldet Estate, Mount Elgon, Kenya Colony:—

Our experience with *Aleurites Fordii* has been that the plants grow very rapidly from seed in the nursery bed, but that on transplanting into the field they appear to sustain a very severe setback from which they may take years to recover. We have planted *A. montana* seed at stake—two to three seeds per hole—with complete success, some of the plants being 6 ft. high after two years from seed. Where seed is expensive (i.e. *A. montana*) we have tried germinating in sand and planting out singly into the field as soon as shoots appear. This also has been satisfactory, plants being 2 ft. to 3 ft. at one year from seed. We have not tried planting *A. Fordii* at stake, but are proposing to do so this year. It seems to us at any rate possible that the lack of success obtained with *A. Fordii* in this district is due to the fact that, as far as I know, all plantations have been transplanted from nursery beds, in which case it is almost impossible to avoid breaking the taproot, instead of planting seed at stake.

On this Mr. F. M. Rogers, Superintendent of Plantations at Amani, remarks:—

My experience at Amani has been that *A. Fordii* does not grow well either planted in seed beds or at stake. Those planted at stake at Bomole were no better than those planted from bamboo pots. We have not raised any in open beds, so that breaking of the taproot has not been possible. I am planting some *A. montana* at stake at Kwamkoro this year in places where male trees are growing; it will be interesting to see if they do better than those planted out in pots.

A further note has been contributed from Nyasaland by Mr. C. C. Webster, Agricultural Officer:—

In Nyasaland both *Aleurites Fordii* and *A. montana* have been planted in each of the following ways:—

(*a*) Seed sown at stake in the field.
(*b*) Seed sown in nurseries and young plants transplanted to the field.
(*c*) Plants allowed to remain a year to eighteen months in the nursery and then cut back and transplanted as stumps.

Planting seed at stake is becoming increasingly popular with planters in the Cholo and Mlanje districts. Two or three seeds are sown at each stake in the early part of the dry season soon after harvesting, and the surrounding ground covered with a thick mulch. The occasional light rainfall which occurs throughout the dry season in these districts is, with the help of the mulch, adequate to keep the soil sufficiently moist for germination, and the plants usually come away well with the onset of the rains. It is unlikely that planting seed at stake during the dry weather would prove satisfactory in the drier districts, but it has also been tried during the rains with fair success.

Stump planting has not been done to the same extent as the other two methods, but some promising plantations have been established in this way. In Cholo and Mlanje districts large plants cut back to a foot or eighteen inches and planted out in May or June have survived the dry season and made good growth with the next rains. Many tung planters in these districts also grow tobacco, which makes a heavy demand on the labour supply at the commencement of the rains, and it is therefore an advantage if tung planting can be done during the drier months. It is mainly for this reason that planting stumps or seed at stake has been tried instead of transplanting seedlings from nurseries with the early rains.

Transplanting from nurseries is, however, still the commonest practice the seed being sown in the beds in June and trans-

planted as soon as sufficient rain has fallen. Provided that the transplanting is done carefully, and that the plants are not too large, very satisfactory results are obtained, and there is no evidence of any setback after planting out as reported from Kenya. In the writer's opinion this is usually the best way to establish tung, and such failures as have recently occurred in Nyasaland with this method have mainly been due to the use of unduly large seedlings.

ACUTE BLOATING OF CATTLE

Acute bloating of ruminants, cattle particularly, may occur at any time from a variety of causes, but most commonly through turning hungry cattle on to luxuriant green feed, or on to herbage country, after heavy rains and when the young herbage is making rapid growth.

Under ranching conditions, where stock are not seen every day, little can be done to prevent losses, but on smaller holdings losses may be minimized if a stack of dry hay is provided to which stock have access before and after being allowed on to green feed. The long, dry hay assists regurgitation, which is difficult when large quantities of short succulent feed has been eaten, and, if it is available, animals will always take a few mouthfuls, with beneficial results.

Symptoms of bloating appear quickly. Animals stop feeding and stand still with arched backs, turning their heads frequently to the abdomen, which increases rapidly in size—the swelling becoming most marked on the left side. As the abdomen enlarges, breathing becomes more and more difficult. In very acute cases the nostrils dilate, the animal stretches out its tongue, bellows, and finally staggers and dies in convulsions.

In less acute cases the development of gas is slower, and frequent belching and vomiting prevents its excessive accumulation. In these cases the use of a gag made from a stick about eight inches long and two inches in diameter, with holes at each end through which a thin rope is run to form a rough bridle—the stick being smeared with tar or grease before being put into the mouth—is of value, as it facilitates belching. Massage of both flanks, applying moderate pressure with both fists upwards and downwards—particularly over the whole of the left flank—while the animal stands with its head uphill, is also beneficial.

Puncture of the rumen with a trocar and canula saves many valuable animals. The instrument must be sterilized by boiling for ten minutes before use. It is wise to keep it ready, wrapped in a sterile towel. The trocar, with its protecting tube, is pushed into the most prominent point of the left flank, usually midway between the point of the hip and the middle of the last rib. Holding the instrument in the left hand, a sharp blow with the palm of the right hand causes it to penetrate the skin, abdominal wall, and the rumen. The point of the trocar is directed towards the right elbow. The trocar is withdrawn gradually from its sheath, allowing the gas to escape slowly, giving immediate relief to the animal. When gas ceases to escape, a cork may be used to close the canula, which is left in position and secured by a clean bandage tied over it and round the body of the animal. Any further accumulation of gas is allowed to escape slowly by removing the cork. When no longer required the canula is withdrawn, and the small puncture dressed with tincture of iodine.

—Reprinted from an article by W. Dixon, Inspector of Stock, in the *Queensland Agricultural Journal*, February, 1939.

REJECTION OF THE FIRST-DRAWN MILK

By M. J. Griffiths

(Reprinted in abridged form from the *Queensland Agricultural Journal*, Jan., 1939, p. 26.)

Dairy farmers' troubles in regard to milk and cream quality usually begin in the cowbail at milking time. It is an unfortunate fact that bacteria of the types most harmful to keeping quality are always to be found in and around the milking shed. They may find their way into milk from many sources—the cow's coat and udder, dried dust and manure, the milker's hands if he neglects to wash them, or the milk utensils.

An additional source of contamination, which is often overlooked, is the small quantity of milk always present, even immediately after milking, within the narrow canal leading from the udder to the outlet of each teat. Here, bacteria entering from outside through the teat opening as soon as the cow lies down, and finding nourishment and a suitable medium and temperature for growth, may multiply and become established in enormous numbers in a few hours. Especially in the case of older cows, where the udder muscles have become slack, the bacteria can penetrate very easily into the teat canal through the enlarged opening.

The first operation, therefore, in clean milk production is the thorough washing of the outside of the cow's udder and teats, and the second is the removal of this first-drawn or "foremilk" so that it does not add large numbers of bacteria to the milk. Two or three streams of milk drawn off into a separate vessel before starting milking into the pail (or before affixing the machine) will be sufficient to wash the teat canal free, or almost free, of contaminating organisms.

The following figures, which are the results of experiments carried out to show the relative average numbers of bacteria found in the first, middle, and last-drawn portions of milk from a herd of twelve cows, show clearly the advantage of rejecting the first streams of milk as well as of grooming the cows and keeping the surroundings clean:—

	Foremilk	Middle	Last Drawn
	Per c.c.	*Per c.c.*	*Per c.c.*
Cows not prepared and shed neglected	26,450	5,880	9,250
Cows groomed, shed neglected	13,720	2,430	3,130
Cows neglected, shed cleaned	13,360	2,200	1,550
Cows and shed cleaned	6,420	1,220	1,720

(Ref. Grant Lockhead, Dept. of Agriculture, Dominion of Canada.)

The work of many investigators shows that almost invariably the foremilk is the most heavily contaminated portion, though results and opinions vary as to the distribution of bacteria throughout the remainder.

It used to be thought that cleanly produced milk must be almost sterile and that all bacteria found in it were from outside sources, but with the advance of dairy science it has been proved that the natural "count" of milk varies enormously according to the individual cow, and that milk as it comes from the udder is rarely, if ever, completely free from bacteria.

The reduction in count obtained by discarding the first three streams of milk from each teat has been found to amount to about 4 per cent of the whole milking. (Ref. Hammer, "Dairy Bacteriology.") This quantity does not at first appear to be very significant, but a consideration of the types of bacteria present will show its importance. In the foremilk are mainly soil and water organisms and coliform

types which are injurious to milk, whilst the flora of the middle and last-drawn portions of milk consist of inert udder types which are natural inhabitants of the normal healthy udder and are not undesirable in milk or harmful to its quality. For the production of clean milk to be used for human consumption, rejection of the first-drawn milk is obviously of assistance in maintaining a high standard of purity and good keeping quality; but in the case of milk production for butter or cheese making also, the practice has more advantages than disadvantages.

The most important reason why *every* farmer should make a practice of removing the foremilk regularly morning and evening is that it enables him to notice anything abnormal in the appearance of the milk. Signs of mastitis usually show up in the form of tiny clots or strings in the first-drawn milk, which, if observed, may mean the early detection of the disease in animals having one or more affected quarters. Special care may then be taken to milk these infected cows last; their milk can be isolated from the rest, and the spread of the disease can be arrested. Neglect or ignorance of mastitis infection, however, in its early stages may have serious and far-reaching effects on the individual cow, on the bulk milk, and on other animals in the herd.

A word of caution is necessary as to the method of removing this first-drawn milk. Under no circumstances must it be withdrawn on to the floor of the milking shed, for this is one of the surest ways of spreading any infection that may be present. Apart from this, decomposition will take place, with accompanying bad smells and attraction of flies.

On many modern milk-producing farms in England a "strip-cup" is used, consisting of a small vessel fitted with a black-enamelled lid, over which each stream of milk passes before flowing through a hole into the cup below. This makes it possible to see at a single glance if any quarter is yielding stringy or abnormal-looking foremilk, and with such a system in use at each milking a case of mastitis cannot become advanced without the knowledge of the milker. Any ordinary small pail or billycan will, of course, serve the purpose, but it should be kept for this only and washed and scalded daily.

The foremilk will not amount to a great quantity except in the case of a large herd, but if it is free from any signs of disease it can be used for calf or pig feeding. It is advisable to pasteurize or bring it up to boiling point and cool before using. If it contains milk from several diseased cows, it is advisable to dispose of it, after adding some disinfectant, by emptying *well* away from the cowbails and water supply. The pail should then be washed, scalded thoroughly, and rinsed with disinfectant.

It is well known that the highest percentage of butterfat in milk is found to be contained in the strippings, and that the first-drawn milk is the poorest portion, showing the lowest butterfat and the highest water percentage. Average analyses of the milk of seven cows, made by Eckles, showed only 10.67 per cent of milk solids to be present in the foremilk, compared with 14.86 in the strippings, the difference consisting almost entirely of fat. Thus thorough stripping of every cow (done gently and not by downward jerking of the udder) will bring its own reward in the form of increased butterfat yield and stimulation of secretion by the milk glands; whilst the loss in butterfat occasioned by removing the first few streams of milk is negligible, and the slight reduction in the quantity is more than off-set by the improvement in keeping quality of the bulk milk.

THE COST OF SEPARATION LOSSES

Every dairyman knows that a loss of milk-fat in separating means loss of money, but many do not realize the full extent of the loss. There is a small amount of fat which is not recoverable by mechanical separation; so this loss is unavoidable. A loss of 0.08 per cent is not excessive, but if it is higher, either the mechanism or the manipulation of the separator is at fault.

The table hereunder will give some idea of the position when the actual loss of fat exceeds the amount which is not recoverable by mechanical means.

Assuming that the average yield of milk is the modest amount of 1 lb. of commercial butter to 25 lb. of milk, the loss will be as follows:—

Loss of:				
0·08	per cent	is equal to	loss of	1 lb. in 50 lb.
0·1	,,	,,	,,	1 lb. in 40 lb.
0·2	,,	,,	,,	1 lb. in 20 lb.
0·4	,,	,,	,,	1 lb. in 10 lb.
0·6	,,	,,	,,	1 lb. in 6·6 lb.
0·8	,,	,,	,,	1 lb. in 5 lb.
1·0	,,	,,	,,	1 lb. in 4 lb.

On the same basis of yield of butter from milk, a herd of cows producing 50 gallons of milk a day will produce in one year 187,062 lb. of milk yielding 7,482 lb. of commercial butter, which at 1s. per lb. is worth £374 2s.

A loss of 0.1 per cent would cause a loss of £9 7s., and a loss of 1 per cent would be equivalent to a loss of £93 10s.

This example will serve to emphasize how necessary it is that a separator should be maintained in perfect order and be operated continually at its correct speed.

—L. A. Burgess, in *Queensland Agric. J.*, Jan., 1939.

INTELLIGENT ANTS

The behaviour of certain tropical ants of the genus Oecophylla[1] involves mental processes strongly suggestive of reason. These ants make large nests in trees by drawing the leaves together and fastening them with silk. But no adult ant can spin silk. The source of the nest-building material, first discovered by Ridley, has been fully described by Doflein and Dodd, and confirmed by others. The ants stretch from leaf to leaf, sometimes in chains several inches long, holding one another round the waist and all pulling together, like boys in a tug-of-war. Gradually the leaves are drawn together. Then, while they are being held in place, other ants bring out larvæ from the nest. The larvæe are capable of spinning silk, originally intended for making the pupal cocoons. Holding these larvæ firmly in their jaws, the ants lift them from side to side of the gap between two leaves, pressing their snouts first to one side and then to the other so that the many threads of silk issuing from the larval mouths eventually sew the leaves together. Co-operation, foresight, and a remarkable adaptability of a process originally developed for a very different function are exhibited in these activities. If performed by human children we would consider it cleverly intelligent.

—From *Fundamentals of Insect Life* (Metcalf and Flint).

[1] One species of this genus is abundant in the coastal districts of East Africa.—*Ed.*

FARM DRAINAGEWAYS AND OUTLETS*

By C. L. Hamilton, Agricultural Engineer, Engineering Section, Soil Conservation Service, Washington, D.C.

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Proper disposal of surface run-off is a major problem in the development of satisfactory farm conservation plans. It is poor planning to expend funds and effort in securing proper land use with contour cultivation, conservation rotations, strip cropping or terraces to conserve the soil on sloping fields, and at the same time to neglect the drainageways which convey concentrated run-off. Ultimate gullying in neglected drainageways will eventually undermine and destroy the soil conservation measures on the adjacent slopes as well as any benefits derived from them. Supporting field examples can be pointed out everywhere. In the South, where terracing with contour tillage has been widely used for many years, inadequate outlets frequently lead to destruction of the terraces and accelerated gullying often to such extent that abandonment of entire fields became necessary. In other sections gullying branching out from unprotected drainageways has destroyed many fields where rotations, contour cultivation and strip cropping were practised.

The location of drainageways and outlets also has a marked effect on the ultimate success of the entire farm conservation plan. Recent field observations directed attention to farms where complete soil conservation practices had been installed but the entire plan failed to secure wholehearted support of the farmer because of improper drainageway locations. Once established, the relocation of drainageways is usually a costly and discouraging undertaking. Proper drainageway locations are largely dependent upon the natural drainage pattern of the area involved. Drainageways located according to property lines, or for the primary purpose of facilitating conservation measures previously installed, often lead to costly or inconvenient farming systems.

The necessity of establishing satisfactory run-off disposal plans at the outset was not generally recognized during the first attempts to develop complete soil conservation plans for individual farms. The earlier efforts were concentrated on problems of proper land use and determination of practical types of practices to check soil losses on individual fields. It was not until many of the resulting farm plans had been established that the importance of over-all run-off disposal plans were fully realized. The installation of many of the plans proved to be uneconomical, while others required costly readjustments before satisfactory results could be obtained. The most disappointing experience resulted from improper location of many of the initial drainageways; their relocation, to facilitate the establishment of subsequent conservation measures on adjacent fields or farms, required extensive readjustments and expense. Even to-day some engineers and conservationists do not fully appreciate the necessity of developing adequate run-off disposal plans at the outset.

* The term "drainageways" refers primarily to channels of surface drainage in the upper reaches of watersheds or in unit drainage basins. "Outlet" is a more restricted term and refers only to drainageways that are provided to receive and convey the discharge from the ends of terraces.

Planning Run-off Disposal Systems

There are two distinct phases in planning farm run-off disposal systems. The initial or general planning involves the selection of the number, type, and location of required drainageways, and of the installation procedure for each. The secondary or detailed planning involves the determination of capacity, design, and construction or establishment details. The former phase should be included in the development of initial farm conservation plans and the following discussion will be limited to this aspect of run-off disposal planning.

The first step in planning a farm run-off disposal system is to make a physical inspection of the farm and the adjacent areas. The main drainage features such as draws, ridges, and slopes should be noted. Their location and condition are of particular importance. Field and property lines, roads, buildings, fences, etc., while of lesser importance, should also be noted. This preliminary inspection will reveal the general drainage characteristics of the area and enable a tentative selection of at least the main depressions that should be reserved for permanent drainageways. The number of lateral drainageways required will depend not only on the topographical features but also on the soil conservation practices to be used. For example, where run-off interception is to be provided by the use of terraces or diversion ditches, the retention of some of the minor depressions as permanent drainageways can often be avoided. On areas where no run-off diversion measures are used, all lateral depressions that carry any appreciable amount of run-off must be reserved as drainageways. As land use and soil conservation plans are developed for the area, the field boundaries, fence lines, and meadow or pasture areas can often be adjusted so as to make it easier to establish and maintain the selected drainageways.

On areas to be terraced the problem of locating and establishing outlets is inseparably associated with planning the terrace system. The cost of terrace construction, and the ultimate success of the terraces, are dependent upon proper planning of outlets. Conversely, adjustments in the location and in the direction of the flow of terraces will often greatly facilitate outlet control. For example, changing the direction of the terrace grade near the centre of a terrace, or running the grade of alternate terraces in opposite directions, will diminish the concentration of run-off and often make it possible to distribute the run-off from a terraced field over native cover on adjoining areas. Where special outlet strips or channels are required, it is often more satisfactory to drain terraces toward the outlet channels from both sides so that each outlet channel will serve a larger area, thus reducing the number required.

It has been found necessary to plan surface drainage systems according to natural drainage units. A drainage unit comprises a natural depression or drainageway together with the land that drains toward it. This means that the initial surface drainage plans for all fields or farms within the drainage unit should be developed concurrently, irrespective of boundary lines. Plans should provide for continuous conveyance of the run-off and economical development of the drainageway from field to field and from farm to farm until a stabilized watercourse is reached. With a properly planned procedure that is in harmony with the natural drainage pattern, drainageways can usually be systematically established, if necessary, by field or farm increments, so that each part can be fitted together without difficulty or expense when the final

conservation job is completed for the entire drainage unit. In some areas the most effective field application of this plan may even involve the co-operative development and maintenance of certain drainageways by two or more landowners. Recent experience has shown that co-operation between landowners and highway officials The sooner this is done the more successful it will be and the smaller will be the expenditure of labour and materials required.

Since much of the native covering has been ploughed up or destroyed and so many drainageways have been severely damaged by gullying, it is necessary to

CLASSIFICATION OF DRAINAGEWAYS AND OUTLETS

DRAINAGEWAYS	NATURAL		CONSTRUCTED		
	Vegetated	Unvegetated	Vegetated	Mechanical	Miscellaneous
Draws (unterraced areas)	Grassed* ..	Rock ..	Meadow strip ..	Drop check	Combination
	Wooded ..	.. ..	Pasture strip ..	Lined† ..	Unlined
Individual terrace outlet..	Grassed slope*	Rock slope	Grassed slope* ..	Drop check	Absorptive
	Wooded slope	.. ..	Wooded slope ..	Lined† ..	Accumulative
Collective terrace outlet..	Grassed* ..	Rock ..	Meadow or pasture strip	Drop check	Combination
	Wooded ..	.. ..	Field or roadside channel ..	Lined† ..	Unlined

*Often referred to as meadow or pasture depending upon how the forage is utilized.

†Discharge velocities are usually higher in lined channels and the channels are sometimes referred to as high velocity.

in the subsequent development of dual-purpose drainageways that carry run-off from the highway right-of-way, as well as from the adjacent farm land, is often advantageous.

SELECTION OF TYPE

Natural drainageways that are still protected by native vegetation should always be given first consideration. They should be protected and utilized to the fullest extent possible because it is usually difficult to re-establish or duplicate these original drainageways and, at best, it is frequently a costly procedure. Natural drainageways that have been only partially damaged by overgrazing, or by the development of a few breaks in the original cover, can usually be repaired or restored. establish many new ones or rebuild old ones. In the re-establishment of these drainageways the results are usually most satisfactory where the natural features are reproduced as nearly as possible. There are some areas, however, where the soil and climatic conditions or artificial conditions introduced with agricultural practices may justify or even necessitate some modification of nature's procedure. It must be recognized that problems of drainageway development are neither equal in importance nor uniform in character in the various climatic, geographic, soil, and type-of-farming regions.

Due to the diversity of conditions encountered, it is obviously impossible to select a standard method of drainageway

protection and attempt to apply it universally. The only satisfactory procedure is to determine in what order the various types of drainageways should be considered and what form of each type is best adapted locally and can be economically established and maintained. From the standpoints of economy and practicability, including ease of establishment, the various types of drainageways should be considered in the following order:—

1. Vegetated individual outlets (terraced areas only).
2. Meadow or pasture strips.
3. Vegetated channels.
4. Mechanical protection.

In field practice the natural conditions encountered will often prohibit the use of certain types, but the types should usually be given consideration in the order named and no method should be discarded as impractical until thorough investigation has proved it to be so.

Pretreatment of Drainageways and Outlets

In most areas it has been found not only hazardous but also expensive to attempt to establish grassed drainageways or outlets at the same time that they are being used for the disposal of run-off. This is particularly true on areas where terraces concentrate additional run-off in the drainageways. Newly prepared seedbeds, seeds, fertilizers, and young plants offer little resistance to erosion, and are frequently washed out unless special precautions are followed. Solid or strip sodding, when properly anchored, will sometimes carry run-off without harmful results immediately after it has been placed. This, however, is a relatively costly method of establishing vegetated drainageways, and the expense retards extensive use of vegetal protection. It is sometimes even difficult to anchor newly placed sod in certain channels in such a way that it will not be damaged by heavy run-off. Damage from run-off is more acute in the establishment of vegetation in outlet channels than in wide grassed drainageways because of the higher velocities produced in the smaller channels. There are several possible methods that can be used to save expense, eliminate the run-off hazards, and make the development of seeded drainageways more dependable and practical.

On areas to be terraced one of the most promising plans is the establishment of outlets before the terraces are constructed. A few years ago a general feeling prevailed that the application of this practice would prove impractical under field conditions. Recent observations and field tests, however, have shown that the establishment of outlets in advance of terracing can, with proper planning, not only be practical but distinctly advantageous in many areas and that it should be given first consideration in the development of any extensive terracing programme. As a result of this practice, some Soil Conservation Service project engineers report that Civilian Conservation Corps camps have been able to accomplish approximately five times as much outlet work as otherwise. They have also been able to establish economical outlet protection where other methods have proved too costly, and the greater accomplishments have resulted in extending the work to many more farms. This experience led to the adoption of the plan as a standard procedure in all field work in Region 2. Establishment of outlets in advance of terracing has also been tried out in Region 4, and is now being extensively advocated in all field work within that region.

The success of this method has been made possible by the complete farm run-off disposal plans which include the number, location, type, and order of drainageway development as a definite part of

preliminary farm conservation planning. The location of all terraces to be used, and their direction of drainage, are also specified in the run-off disposal plans. Where this practice is not followed, it is difficult effectively to establish outlets in advance of terrace construction. It is important that the outlets be located and constructed so as to facilitate later terrace construction. Otherwise, they cannot be efficiently used when the final conservation measures are installed and they will represent wasted efforts and expenditures.

For the most effective use of pre-established outlets, the order of terrace construction is largely determined by the order in which established outlets can be made available. Terrace construction is arranged so that the areas for which natural outlets are available, or for which outlet channels require solid sodding or mechanical protection, can be terraced the first year while the vegetation is becoming established in other outlets. Outlets must be established as early as possible in order that the final terrace construction work will not be delayed. The change from the common practice of treating outlets following terracing to the new practice of establishing outlets in advance of terracing will involve a transition period in any terracing programme. During this period it may be advisable to establish part of the outlets after terracing so that the terrace construction work may be continued without undue interruption. The length of the transition period will largely depend upon the additional effort directed to outlet construction or the rate at which outlet construction can be temporarily accelerated. The normal rate of outlet construction can be resumed once the outlets are well in advance of terrace construction. The shorter the transition period can be made, the sooner the full benefits of pre-established outlets can be achieved.

Where grassed drainageways are to be established by seeding on unterraced areas or on terraced areas where established outlets are not available, the use of some form of temporary run-off protection is often advantageous. Even with pre-establishment of outlets on areas to be terraced it is often necessary to provide some additional run-off protection during the period in which the grasses are becoming established. In the South, where Bermuda grass is commonly used for drainageway protection, the problem seems to be somewhat less acute. Here the Bermuda grass is usually established from rootstalks and stolons by spot, spring, or broadcast sodding. During the initial stages, however, even this procedure is often benefited by some form of temporary run-off protection.

The practice of diverting the run-off, by means of temporary dikes or ditches, until the vegetation becomes established in the permanent drainageway is often used. The use of a quick-growing annual crop, to stabilize the drainageway before seeding the grasses, is sometimes advisable. Small grains or Sudan grass, domestic ryegrass and similar crops may be seeded in the spring to hold the soil effectively and produce a residue in which to seed the grasses the following fall. Nurse crops may also be seeded with the grasses to afford quick protection, but care must be exercised not to seed too lavishly. Where practical, such run-off retention measures as contour ridging, furrowing, listing, and subsoiling on the contributing watershed, may sufficiently reduce the run-off temporarily to assure satisfactory establishment of drainageway vegetation. On some areas where pre-established outlets were not available, it has been found that subsoiling only the terrace channels and outlets, to a depth of about 18 inches, reduced the run-off sufficiently during the

following year to permit the establishment of satisfactory vegetal protection in the outlets.

Providing new grass seedings with some form of surface protection has also facilitated the establishment of drainageway vegetation in some sections. Surface mulching not only protects newly prepared seedbeds, seed, and small plants from run-off and hard rains, but it conserves moisture and produces a surface condition that encourages the germination and growth of small grass seeds. The mulch can be produced by properly anchoring a thin but continuous layer of straw, corn fodder, old hay, or fine brush over the entire seeded area. Loosely woven burlap, tightly drawn and staked to hold it in place, provides good surface protection. While this treatment is more expensive, it may frequently be used advantageously on small areas or at vulnerable points in larger areas. Regardless of which method of run-off protection is used, it is essential that adequate seedbed tilth and fertilization be provided, and that suitable seeding rates and mixtures be used for satisfactory results. Even with run-off protection, it cannot be expected that grasses and legumes will thrive well where topsoil and necessary fertility are lacking.

MILK IN ITS NUTRITIONAL AND ALLIED ASPECTS

An interesting series of papers read at a meeting of the British Association in March, 1939, has come to hand.

Dr. Harriette Chick, C.B.E., of the Lister Institute, in surveying the complex composition of milk and the high value of the components, pointed out that skimmed milk might be accorded a much more important place in human dietaries than at present; an inexpensive by-product of butter manufacture, skimmed milk is very rich in lime salts, phosphates and valuable protein. Milk is a dangerous foodstuff, however, in that its very highly nutritive qualities make it an excellent medium for the rapid growth of bacteria and a vehicle for the spread of disease germs.

In view of the great nutritional value of milk and the unhappy incidence of bovine tuberculosis, undulant fever, typhoid epidemics, gastro-enteritis, and other diseases attributable to raw milk, Professor J. C. Drummond (Professor of Biochemistry, University College, London) stressed the importance of pasteurization of milk.

It is popularly believed that heating reduces the digestibility of milk proteins, changes the solubility of the lime-containing constituents, and destroys the vitamins. These are the arguments used by those who oppose pasteurization proposals, and Professor Drummond proves by a survey of recent research and laboratory experiments on the subject that these arguments are fallacious.

It has been satisfactorily proved that there is no significant difference between the digestibility of raw and pasteurized milk nor any lowering of the nutritive value of the proteins, even in evaporated milk, where it is admitted that there is a very slight loss in vitamin content.

Vitamin A and vitamin D withstand heat without any detectable destruction, and the vitamin B content is so very slightly reduced that, as milk is a very unimportant source of vitamin B in the human diet, too much importance need not be attached to this finding.

Recent work had further shown that the anti-scorbutic vitamin C is not endangered by heat but by light. If milk

could be pasteurized straight from the udder without coming into contact with light, its anti-scorbutic power would be unassailed, as the ascorbic acid in milk is thus not converted into a biologically inactive oxidized form.

Experiments in milk feeding have been carried out on rats, whose small life cycle is readily reviewable; on eight thousand children, and on calves. This last group is of most importance, as cow's milk was designed by nature to provide for the growth and development of calves, and if pasteurization of milk has an ill effect it will be revealed most readily in calf-rearing. But Professor Drummond's evidence in favour of pasteurization is weighted still further when he says, quoting the Milk Nutrition Committee's Report, 1938: "Raw milk has for calves a nutritive value almost identical with that of pasteurized milk, and a considerable risk of spreading T.B. among calves is incurred if they are given commercial raw milk."

Dr. A. W. Scott, of the Royal Technical College, Glasgow, reiterated that pasteurization of milk means holding the temperature at 145 to 150 degrees F. for not less than thirty minutes and cooling to at least 50 degrees F., with no possibility of recontamination after holding. He pointed out further that where pasteurization is supposed to be carried out to-day, there is not always evidence of proper treatment, because pasteurizing plants have not been kept to the required standard of efficiency.

Where pasteurization becomes compulsory, it will be the duty of urban local authorities to see that the plants are regularly supervised for proper sterilizing equipment and scrupulous accuracy of thermometers.

The advantages of compulsory pasteurization to the urban consumer are so great that it must eventually become law, and it is the duty of all those in a position to do so to educate public opinion to recognize the benefits which would result from such a step.

In a paper on distribution and cost, Mr. J. Cripps laid stress on the need for the reduction of the high distributive costs of milk, due to the large number of small concerns engaged in the business, in many cases competing with each other and causing a large amount of overlapping. It is suggested that these distributive costs could be lowered either by the distribution of all liquid milk supplies in towns by the municipal authorities, or alternatively by the extension of distribution by co-operative societies, which already handle a large volume of liquid milk. It is considered that a reduction of distributive costs would lead to a further increase in demand. This system of municipal distribution might be worth consideration in Kenya, since it would enable milk to be sold under better conditions, would prevent adulteration, and would lower costs and eliminate unnecessary competition.

K.M.B.

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